ESSENTIAL MATHEMATICS

UNITS 1 & 2

CAMBRIDGE SENIOR MATHEMATICS
FOR QUEENSLAND

NEIL CAPPS | LEANNE BUTLER | DEBORAH BURTON | CASSIE MCKENZIE

INCLUDES INTERACTIVE TEXTBOOK POWERED BY CAMBRIDGE HOTMATHS

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A2.4 Guide to problem-solving and modelling, and complex unfamiliar questions

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About the authors

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Neil Capps is the Head of Mathematics at Glasshouse Christian College and has 29 years' experience in teaching. Neil has also taught in the State and Catholic school systems as well as in a variety of Christian schools. Though teaching mainly in Queensland, he taught for four years in Darwin and has also worked as a School Principal in northern New South Wales. Neil is passionate about mathematics education and has enjoyed the implementation of the new curriculum and encouraging both teachers and students to develop their love of mathematics.

Leanne Butler

Leanne Butler is Curriculum Leader of Mathematics at Downlands College in Toowoomba. She has 28 years' teaching experience across all levels from Years 7 to 12 at various schools across south-east Queensland and NSW. She has a keen interest in helping students overcome their apprehension towards mathematics by exploring how students learn mathematics and finding real-life relevance for simple and complex mathematical concepts.

Deborah Burton

Deborah Burton has taught across all age groups from kindergarten, primary, and secondary to adult education, specialising in mathematics. She has a passion for teaching mathematics, with the fruits of her labour being well rewarded with her students performing well academically. She believes that learning is a life-long process for teachers, as well as for students.

Cassie McKenzie

Cassie McKenzie has taught mathematics for 12 years in South Australia and Queensland. Cassie initially struggled with mathematics in high school before the combination of a brilliant teacher and excellent resources meant that she went on to excel in the subject during senior school and university. Cassie is passionate about instilling a love for mathematics by assisting students to gain confidence and find enjoyment through the challenge of mathematics.

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Introduction and overview

Cambridge Senior Mathematics for Queensland Essential Mathematics Units 1&2 has been written from the ground up to the QCAA syllabus to be implemented in Year 11 from 2019. Its four components — the print book, downloadable PDF textbook, online Interactive Textbook and Online Teaching Resource* — contain a great range of resources, including worked solutions and revision of Year 10 material, available to schools in a single package at one convenient price. There are no extra subscriptions or per-student charges to pay.

**The Online Teaching Resource is included with class adoptions, conditions apply.*

► Overview of the print textbook (shown on the page opposite)

1. **Syllabus references** are listed at the beginning of each chapter.
2. **Pre-tests** provide a check of requisite knowledge and skills. Links are provided to access HOTmaths lessons from earlier years as revision for those students who need it.
3. **Learning goals** based on the syllabus are given for each section.
4. **What you need to know** boxes list important concepts and principles in concise and accessible format.
5. **Worked examples** detail thinking and the solution in a logical sequence, and are linked to exercises. Video versions are provided in the interactive textbook to encourage independent learning.
6. Exercises are divided into:
   - **Fundamentals –** integrating the Fundamental topic: Calculations throughout the topic, as required by the syllabus.
   - **Applications**: questions in real-life contexts, differentiated into degree-of-difficulty categories as indicated by a bar:

SF: 5–10	CF: 11–15	CU: 16, 17
Simple Familiar	**Complex Familiar**	**Complex Unfamiliar**

An exercise that covers only complex subject matter has only CF and CU questions; an exercise that covers only simple subject matter has only SF questions. Some exercises cover both simple and complex subject matter, so have questions in all three categories.

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Applications questions are also differentiated into **learning-style** and **assessment-style**, the latter category being marked by a star ★. Learning-style questions are scaffolded with steps that guide students to the answer, while assessment-style questions are unscaffolded and are suitable models for examinations or other assessment items. Questions requiring technology other than scientific calculators are learning-style.

7 **Problem-solving and modelling tasks** are provided for every chapter, set out in stages with a flowchart based on the approach to problem-solving and mathematical modelling used by QCAA.

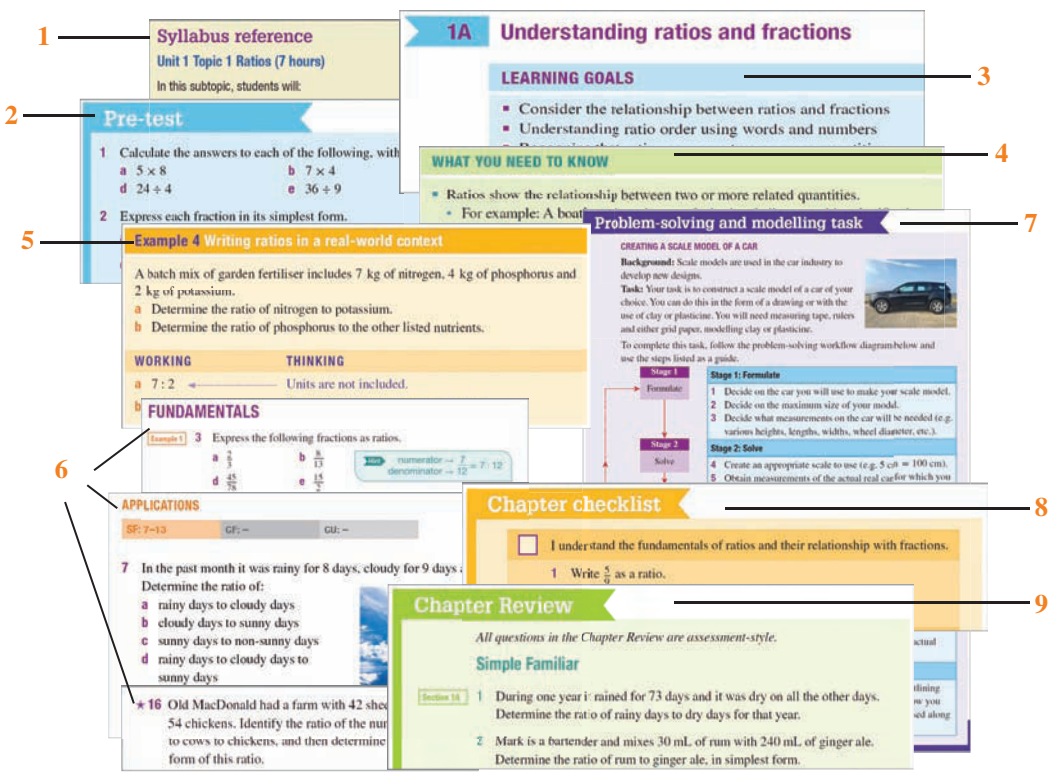
8 **Chapter checklists** comprise short questions assessing achievement of learning goals.

9 **Review** exercises contain only assessment-style questions organised under degree-of-difficulty subheadings.

10 Examples and questions using **spreadsheets** are integrated throughout the text, with accompanying Excel files in the Interactive Textbook.

11 Additional linked resources in the Interactive Textbook and Online Teaching Suite such as practice assessment items are indicated by icons or notes in the text.

Print book features — numbers refer to points above


1
Syllabus reference
Unit 1 Topic 1 Ratios (7 hours)
In this subtopic, students will:
1A Understanding ratios and fractions
LEARNING GOALS
Consider the relationship between ratios and fractions
Understanding ratio order using words and numbers
3
2
Pre-test
1 Calculate the answers to each of the following, with
a 5 × 8
b 7 × 4
d 24 ÷ 4
e 36 ÷ 9
2 Express each fraction in its simplest form.
4
WHAT YOU NEED TO KNOW
Ratios show the relationship between two or more related quantities.
For example: A boat
5
Example 4 Writing ratios in a real-world context
A batch mix of garden fertiliser includes 7 kg of nitrogen, 4 kg of phosphorus and 2 kg of potassium.
a Determine the ratio of nitrogen to potassium.
b Determine the ratio of phosphorus to the other listed nutrients.
WORKING
THINKING
a 7 : 2
Units are not included.
7
Problem-solving and modelling task
CREATING A SCALE MODEL OF A CAR
Background: Scale models are used in the car industry to develop new designs.
Task: Your task is to construct a scale model of a car of your choice. You can do this in the form of a drawing or with the use of clay or plasticine. You will need measuring tape, rulers and either grid paper, modelling clay or plasticine.
To complete this task, follow the problem-solving workflow diagram below and use the steps listed as a guide.
Stage 1
Formulate
Stage 2
Solve
Stage 1: Formulate
1 Decide on the car you will use to make your scale model.
2 Decide on the maximum size of your model.
3 Decide what measurements on the car will be needed (e.g. various heights, lengths, widths, wheel diameter, etc.).
Stage 2: Solve
4 Create an appropriate scale to use (e.g. 5 cm = 100 cm).
5 Obtain measurements of the actual real car for which you
FUNDAMENTALS
3 Express the following fractions as ratios.
6
APPLICATIONS
7 In the past month it was rainy for 8 days, cloudy for 9 days
Determine the ratio of:
a rainy days to cloudy days
b cloudy days to sunny days
c sunny days to non-sunny days
d rainy days to cloudy days to sunny days
★16 Old MacDonald had a farm with 42 she
54 chickens. Identify the ratio of the nu
to cows to chickens, and then determine
form of this ratio.
Chapter checklist
8
I understand the fundamentals of ratios and their relationship with fractions.
1 Write 5/10 as a ratio.
Chapter Review
9
All questions in the Chapter Review are assessment-style.
Simple Familiar
1 During one year it rained for 73 days and it was dry on all the other days. Determine the ratio of rainy days to dry days for that year.
2 Mark is a bartender and mixes 30 mL of rum with 240 mL of ginger ale. Determine the ratio of rum to ginger ale, in simplest form.

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▶ Downloadable PDF textbook

12 The convenience of a downloadable PDF textbook has been retained for times when users cannot go online.

13 PDF annotation and search features are enabled.

▶ Overview of the interactive textbook (shown on the page opposite)

The **Interactive Textbook (ITB)** is an online HTML version of the print textbook powered by the HOTmaths platform, included with the print book or available as a separate digital-only product.

14 The material is formatted for on screen use with a convenient and easy-to-use navigation system and links to all resources.

15 **Definitions** pop up for key terms in the text and are also provided in a printable online **glossary**, while the HOTmaths dictionary is also accessible.

16 Examples have **video versions** to encourage independent learning.

17 The **Desmos scientific calculator**, graphics calculator and geometry tool are also available for students to use for their own calculations and exploration.

18 **Spreadsheets** are provided in Excel format.

19 **Quick quizzes** containing automarked multiple-choice questions enable students to check their understanding.

20 Previous years' **HOTmaths lessons** are provided for revision of prior knowledge and skills, linked below Pre-Tests.

21 The new **Workspaces** enable students to enter working and answers online and to save them. Input is by typing, with the help of a symbol palette, handwriting and drawing on tablets, or by uploading images of writing or drawing.

22 The new **self-assessment tools** enable students to check answers, mark their own work, and rate their confidence level in their work. This helps develop responsibility for learning and communicates progress and performance to the teacher. Student accounts can be linked to the learning management system used by the teacher in the Online Teaching Suite.

23 **Worked solutions** are included and can be enabled or disabled in the student accounts by the teacher.

24 **Practice assessment** items are provided in downloadable PDF and Word files.

25 **Online appendices** provide a glossary of terms and cognitive verbs, guides to spreadsheets and the Desmos graphing calculator, links to scientific calculator guides, and guides to problem-solving, modelling and approaching complex unfamiliar problems.

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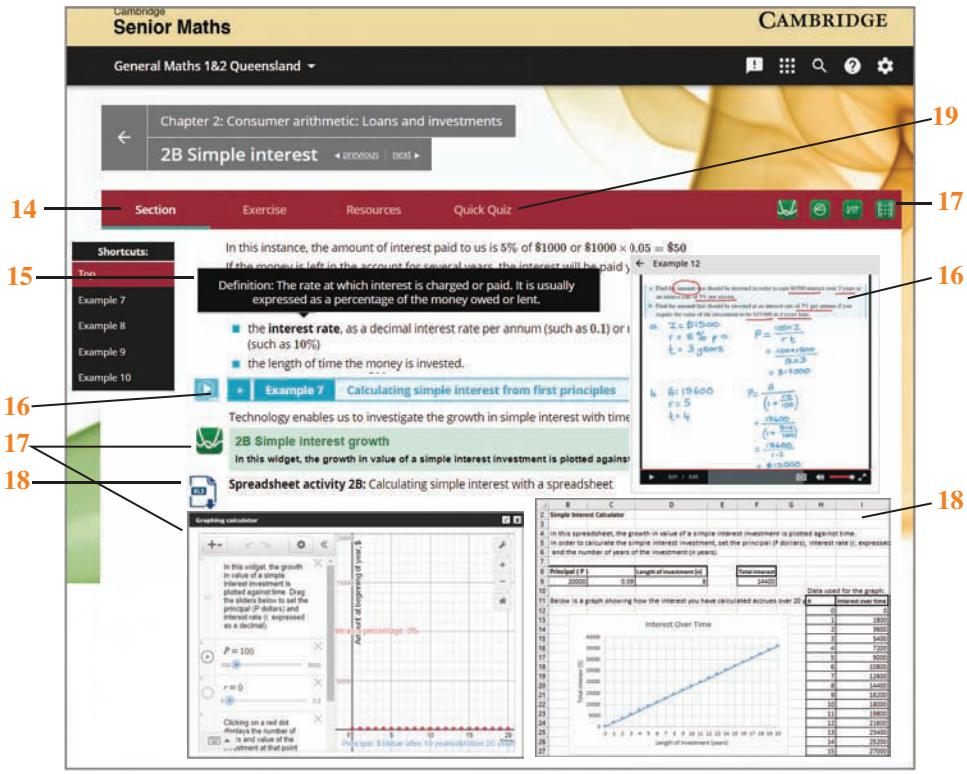
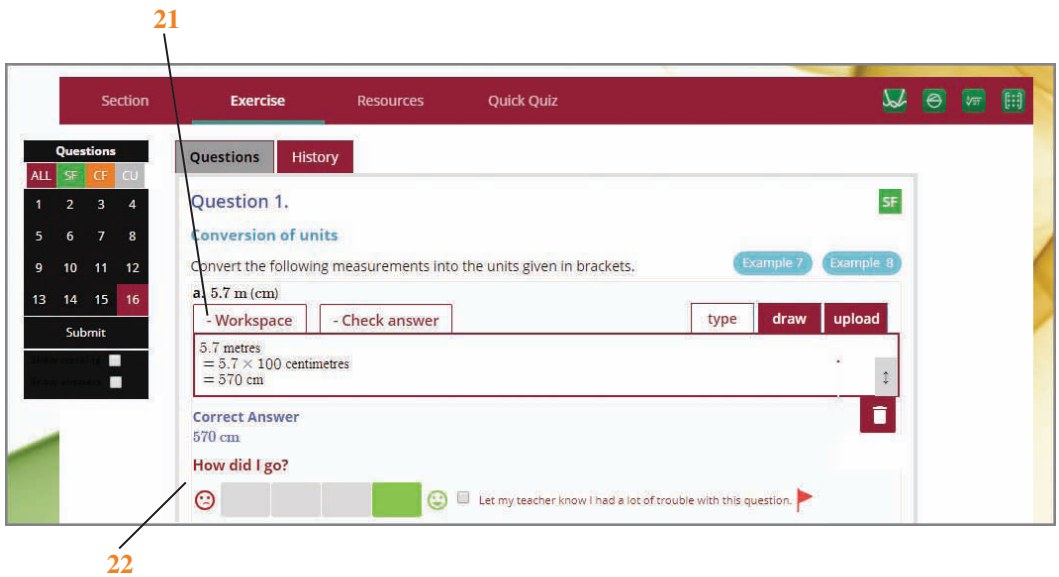


Workspaces and self-assessment



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► Online teaching suite (shown below)

The Online Teaching Suite is automatically enabled with a teacher account and is integrated with the teacher's copy of the Interactive Textbook. All the assets and resources are in one place for easy access. The features include:

26 The HOTmaths learning management system with class and student analytics and reports, and communication tools.
27 Teacher's view of a student's working and self-assessment.
28 A HOTmaths-style test generator.
29 Chapter test worksheets as PDFs and editable Word documents.
30 Assessment practice items as PDFs and editable Word documents.
31 Editable curriculum grids and teaching programs.

Online teaching suite powered by the hotmaths platform

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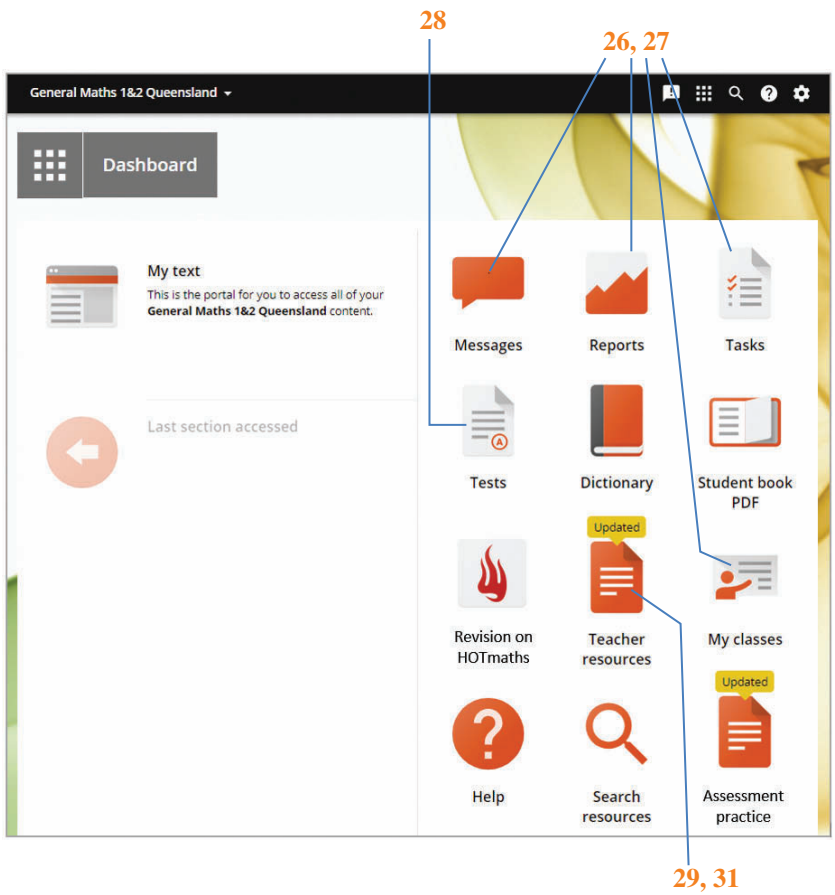

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1 Ratios

Maths for a landscape gardener: Jan McArthur

Jan McArthur runs her own business as a landscape gardener in the Sunshine Coast hinterland. Before that, she was a pathology laboratory technician and scientist for 20 years in a major Brisbane hospital.

Tell us a bit about your job. What does a typical day look like?

In my previous job as a scientist in a pathology laboratory, I worked indoors mixing solutions, reagents and analysing blood samples. Today, I follow my passion and work outdoors. I wake up with the sun and maintain a large garden. I grow vegetables, native plants and exotics. I mow lawns, whipper snip, trim hedges, manage weeds and keep plants healthy and watch them grow!

What maths did you study at school?

I was educated in a small country town in Victoria. When I went to school, women were not encouraged to study maths. I studied maths until my fifth year of secondary school but completed my Higher School Certificate the following year without maths. However, upon entry to university as a mature-age student I completed further maths studies and a few other subjects to allow me to study science.

How do you use maths in your job? Could you give some examples?

When I worked in a pathology laboratory in a large hospital, I was responsible for preparing, analysing and interpreting test results. This would involve calculating volumes using ratios to make reagents and solutions.

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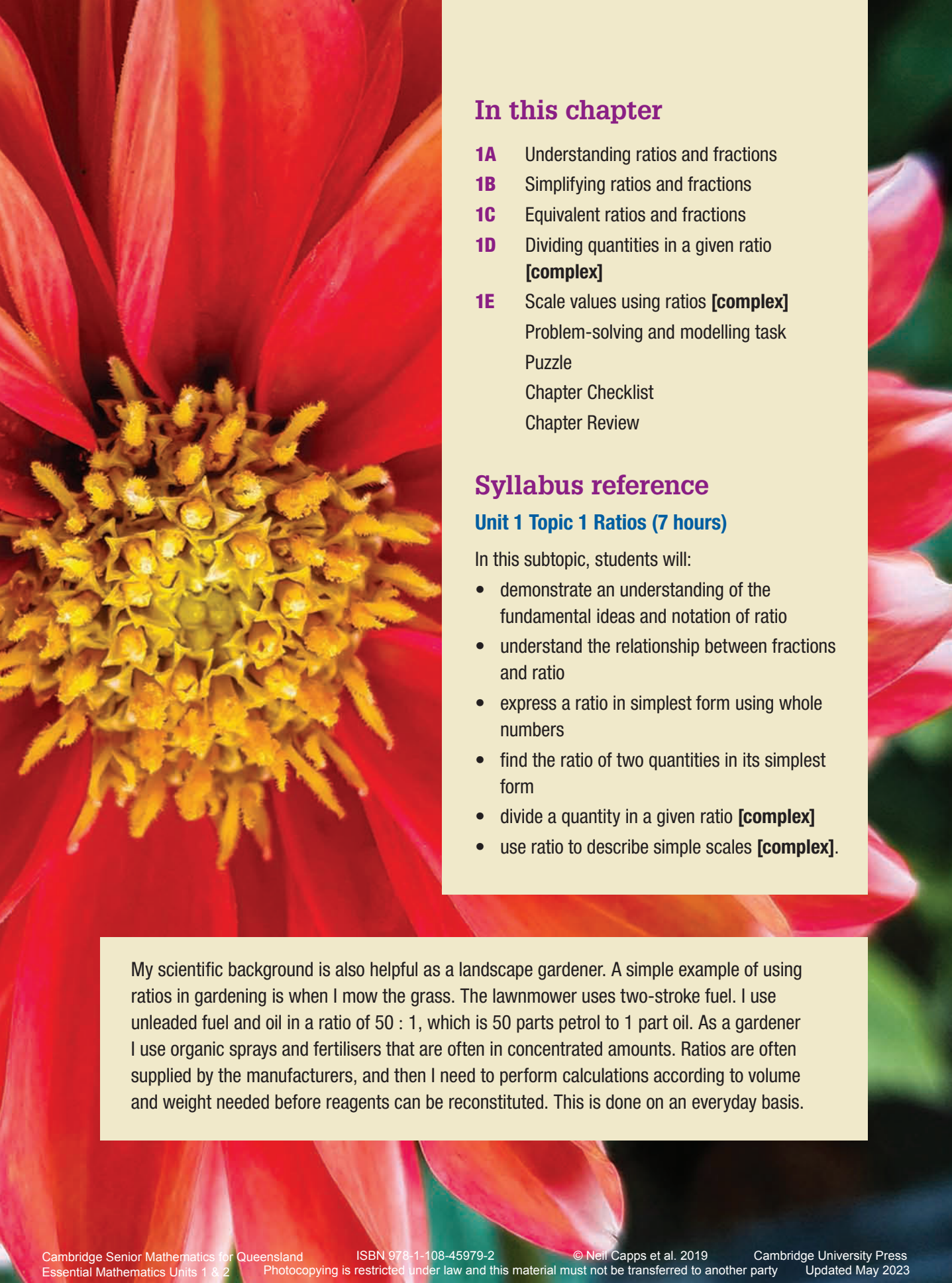

In this chapter

1A Understanding ratios and fractions
1B Simplifying ratios and fractions
1C Equivalent ratios and fractions
1D Dividing quantities in a given ratio **[complex]**
1E Scale values using ratios **[complex]**
Problem-solving and modelling task
Puzzle
Chapter Checklist
Chapter Review

Syllabus reference

Unit 1 Topic 1 Ratios (7 hours)

In this subtopic, students will:

- demonstrate an understanding of the fundamental ideas and notation of ratio
- understand the relationship between fractions and ratio
- express a ratio in simplest form using whole numbers
- find the ratio of two quantities in its simplest form
- divide a quantity in a given ratio **[complex]**
- use ratio to describe simple scales **[complex]**.

My scientific background is also helpful as a landscape gardener. A simple example of using ratios in gardening is when I mow the grass. The lawnmower uses two-stroke fuel. I use unleaded fuel and oil in a ratio of 50 : 1, which is 50 parts petrol to 1 part oil. As a gardener I use organic sprays and fertilisers that are often in concentrated amounts. Ratios are often supplied by the manufacturers, and then I need to perform calculations according to volume and weight needed before reagents can be reconstituted. This is done on an everyday basis.

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Pre-test

1 Calculate the answers to each of the following, without using a calculator.

a 5×8 **b** 7×4 **c** 3×9

d $24 \div 4$ **e** $36 \div 9$ **f** $56 \div 7$

2 Express each fraction in its simplest form.

a $\frac{3}{6}$ **b** $\frac{14}{21}$ **c** $\frac{15}{20}$

d $\frac{12}{48}$ **e** $\frac{50}{70}$ **f** $\frac{250}{400}$

3 Use multiplication to fill in the missing numbers to make equivalent fractions.

a $\frac{3}{4} = \frac{\square}{12}$ **b** $\frac{2}{9} = \frac{6}{\square}$ **c** $\frac{2}{5} = \frac{12}{\square}$

4 Use multiplication or division, as appropriate, to convert the given quantity to the units shown in the brackets.

a 25 cm (m) **b** 1.5 days (h)

c 2500 mL (L) **d** 0.75 m (mm)

e 2.3 kg (g) **f** 1 hour (s)

Hint First write both amounts in the same unit.

5 Express the first quantity as a fraction of the second.

a 500 m, 2 km **b** 8 weeks, 1 year **c** 2 L, 4000 mL

d 6000 mm, 15 m **e** 10 h, 1 day **f** 25 mm, 50 cm

6 Calculate:

a $\frac{1}{2}$ of \$30 **b** $\frac{3}{4}$ of \$100 **c** $\frac{5}{8}$ of \$64

7 Determine the highest common factor (HCF) of each pair of numbers.

a 12, 18 **b** 20, 100 **c** 15, 36

Hint The HCF is the largest shared factor.

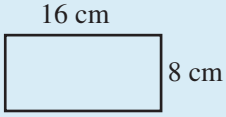
8 Determine the lowest common multiple (LCM) of each pair of numbers.

a 4, 6 **b** 10, 12 **c** 15, 30

Hint The LCM is the smallest shared multiple.

9 For each of these rectangles, determine the simplified ratio of length : width.

a



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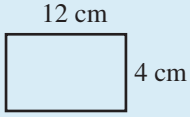

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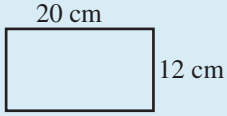

A link to a HOTmaths lesson is provided in the Interactive Textbook to revise this topic.

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1A Understanding ratios and fractions

LEARNING GOALS

- Consider the relationship between ratios and fractions
- Understanding ratio order using words and numbers
- Recognise that ratios compare two or more quantities
- Identify ratios in real-world circumstances

Why are ratios essential?

Ratios are found often in many aspects of life. They help with comparing prices in supermarkets; with mixing oil and petrol to create fuel for cars, mowers and boats; and with administering medicine in hospitals. You use ratios whenever you're deciding how to break up a restaurant bill between you and your friends.

Bicycle designers, mechanics and competitors use gear ratios to calculate the roll-out distance per pedal revolution. Altering gear ratios can increase acceleration and maximum speed.

WHAT YOU NEED TO KNOW

- Ratios show the relationship between two or more related quantities.
  - For example: A boat's outboard motor fuel mix of oil to petrol is a 1 : 40 mix; that is, 1 mL of oil to 40 mL of petrol.
- A **ratio** compares amounts with the same units but it is written without units.
- The **colon** '**:**' is the mathematical symbol that operates the same way as the horizontal line in a fraction.
- The ratio $a : b$ can be read as the ratio of 'a to b' or 'a is to b'.
- The order of the writing of a ratio is important. The word 'respectively' means in the same order.
- The numbers in a given ratio follow the same order that the items are listed in a sentence.
- Ratios should be written in the same units before they are simplified.

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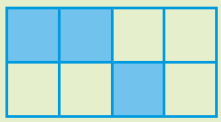
- When expressing a ratio as fractions, the total amount of parts needs to be considered and two answers are required.
  e.g. the ratio of shaded to unshaded parts is 3 : 5.
  Total parts $= 3 + 5 = 8$
  Shaded fraction $= \frac{3}{8}$
  Unshaded fraction $= \frac{5}{8}$



Example 1 Expressing ratios as fractions

a Express 34 : 63 as fractions.

b Express $\frac{19}{32}$ as a ratio.

WORKING	THINKING
a Total parts $= 34 + 63 = 97$ Fractions: $\frac{34}{97}$ and $\frac{63}{97}$	A fraction is a proportion of the whole. Each part of the ratio is expressed as its own fraction.
b $\frac{19}{32} = 19 : 13$ Total parts $= 32$ First part $= 19$ Second part $= 32 - 19 = 13$ Ratio $= 19 : 13$	The fraction is a proportion of the whole, but the ratio compares two parts of the whole. We calculate the second part by subtracting the first part from the whole.

Example 2 Understanding the order of a ratio

Use words and numbers to write the given ratio, then interpret the ratio.

a When making bread, Julie uses flour and liquid in the ratio of 5 : 3.

b At a school camp, the ratio of students to teachers is 13 : 2.

WORKING	THINKING
a Flour : liquid $= 5 : 3$ For every 5 parts of flour there are 3 parts of liquid.	The question lists flour first, then liquid.
b Students : teachers $= 13 : 2$ For every 13 students there are 2 teachers.	The question lists students first, then teachers.

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Example 3 Writing ratios that compare two or more quantities

A fruit bowl contains 3 bananas, 6 apples and 5 oranges. Use this information to identify the following ratios.

a bananas to oranges

b apples to bananas to oranges

c oranges to the total number of pieces of fruit

WORKING	THINKING
a 3 : 5	Write the number of bananas (3) to the number of oranges (5).
b 6 : 3 : 5	Write the number of apples (6) to the number of bananas (3) to the number of oranges (5).
c 5 : 14	Write the number of oranges (5) to the total number of fruit ($3 + 6 + 5 = 14$).

Example 4 Writing ratios in a real-world context

A batch mix of garden fertiliser includes 7 kg of nitrogen, 4 kg of phosphorus and 2 kg of potassium.

a Determine the ratio of nitrogen to potassium.

b Determine the ratio of phosphorus to the other listed nutrients.

WORKING	THINKING
a 7 : 2	Units are not included.
b 4 : 9	Nitrogen and potassium $= 7 + 2 = 9$

Exercise 1A

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in each of the following.

a The _____ of the writing of a ratio is important.

b The numbers in a given ratio follow the _____ order that the items are listed in a sentence.

c Ratios should be written in the same _____ before they are simplified.

d A simplified ratio compares amounts with the _____ units but it is written _____ units.

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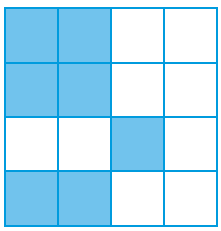
2 For each diagram:

i Determine the ratio of shaded parts to unshaded parts.

ii Determine the fraction of shaded parts to total parts.

iii Determine the ratio of unshaded parts to total parts.

a



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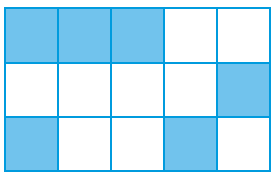

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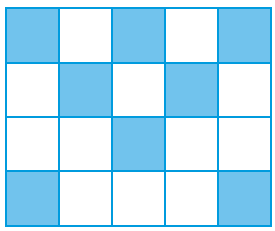

Example 1

3 Express the following fractions as ratios.

a $\frac{2}{3}$ **b** $\frac{8}{13}$ **c** $\frac{22}{37}$

d $\frac{45}{78}$ **e** $\frac{15}{22}$ **f** $\frac{9}{14}$

g $\frac{14}{19}$ **h** $\frac{7}{12}$

Hint: First part → $\frac{7}{12}$ = 7 : 5
Whole → 12
Second part = 12 − 7 = 5

Example 2

4 Express the following ratios as fractions.

a 3 : 5 **b** 6 : 11 **c** 31 : 211 **d** 42 : 77

e 7 : 15 **f** 8 : 17 **g** 9 : 5 **h** 57 : 36

Example 3

5 **a** When students attend a swimming excursion, there are regulations that state that the student to teacher ratio should be 12 : 1. Use words and numbers to write the given ratio, then interpret the ratio.

b When making a cake mix, flour and sugar are used in the ratio 3 : 2. Use words and numbers to write the given ratio, then interpret the ratio.

6 Use the information to write the following as ratios.

a 5 rainy days to 8 sunny days

b 3 cups of sugar to 5 cups of flour

c 11 eggs to 14 eggs

d 7 tries to 12 tries

e 8 cats to 11 dogs

f 4 cups of milk to 5 cups of water

Hint: A ratio compares amounts with the same units but it is written without units.

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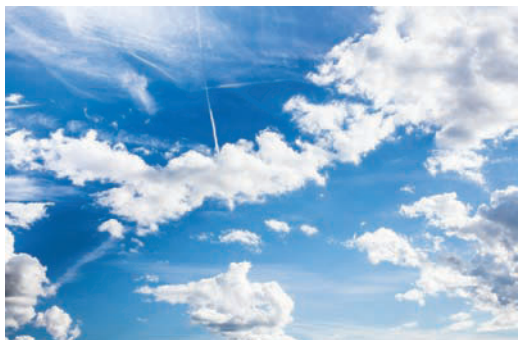
APPLICATIONS

SF: 7–13 | CF: – | CU: –

7 In the past month it was rainy for 8 days, cloudy for 9 days and sunny for 14 days. Determine the ratio of:

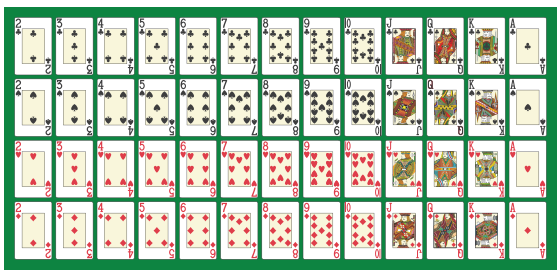
a rainy days to cloudy days
b cloudy days to sunny days
c sunny days to non-sunny days
d rainy days to cloudy days to sunny days



Hint The order of numbers is important in a ratio.

Example 4

8 In a standard deck of 52 playing cards there are four suites, each with the following 13 cards: ace, numbers 2 to 10, jack, queen and king. Spades and clubs are black cards, whereas diamonds and hearts are red cards.
Determine the ratio of:



a black cards to red cards
b spades to red cards
c hearts to non-hearts
d aces to non-aces

9 In a new housing estate, the town planners make a requirement that for every 10 000 m^2 of development there must be 750 m^2 of green space. Determine the ratio of development area to total green space, in simplest form.

Hint Start with the words: 'Development area to green area = …'.

10 When children are learning to play tennis, the recommended ratio of children to coaches for each age level are those given in the table.

Age (years)	Ratio
4–6	5 : 1
7–9	6 : 1
10–12	7 : 1
13+	1 : 1

a Konrad is 8 years old. Identify the ratio of children to coaches for his age group.
b Use this ratio to determine how many other children Konrad would expect to be with him during his training session.

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11 A group of New York City residents are concerned about the increasing amount of shadow in Central Park, cast from the many new, super tall buildings.

a Consider the image and **assess** (i.e. form an **estimate** of) the proportion of the park that is in shadow from buildings. Write this estimate as a whole number ratio of shadow area to park area.

b Use your estimated ratio to **propose** (i.e. make a suggestion about) approximately what percentage of this park is currently in the shadow of a building.

Sheep Meadow in Central Park, New York City

12 Symbolise the following ratios using a picture or diagram.

a 1 : 3 **b** 4 : 9

13 Measure the length of your hand from the wrist to the end of your pointer finger, and measure your foot from the heel to the tip of your toes. Compare these two measurements using a ratio.

Hint Ratios are written using whole numbers without units.

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1B Simplifying ratios and fractions

LEARNING GOALS

- Write fractions in simplest form by dividing the numerator and denominator with the HCF
- Write whole number ratios in simplest form by division of each part with the HCF
- Simplify fraction ratios by multiplication with the LCM
- Simplify ratios by first converting quantities to the same units
- Simplify ratios in real-world situations

Why is it essential to simplify ratios?

It is through the simplification of ratios that we can usefully compare them. Examples include comparing win to loss ratios of sporting events; comparing the aspect ratios of images or devices; comparing map scale ratios; and comparing price to weight ratios when calculating the cheapest way to purchase items.

We can also use simplification of ratios when comparing statistics. For example, in Brisbane the ratio of males to females simplifies to 49 : 50.

Surveyors calculate 'closure ratio'. A 40 cm discrepancy after an 8 km traverse gives a closure ratio of 40 cm : 8 km = 1 : 20 000.

WHAT YOU NEED TO KNOW

- The **highest common factor** (**HCF**) is the largest number that can be divided exactly (i.e. with no remainder) into two or more numbers.
  - For example: For 12 and 18, the HCF = 6.
  - The HCF is *smaller* than or equal to each given number.
- The **lowest common multiple** (**LCM**) is the lowest whole number that is exactly divisible by two or more numbers. The LCM is the lowest shared multiple.
  - For example: For 20 and 30, the LCM = 60.
  - The LCM is *greater* than or equal to each given number.
- The **lowest common denominator** (**LCD**) is the lowest whole number that is exactly divisible by two or more denominators. The LCD is the LCM of the denominators.

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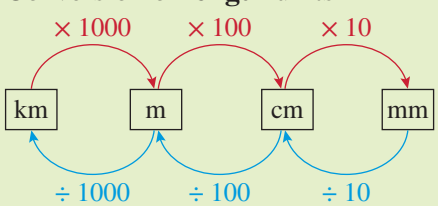
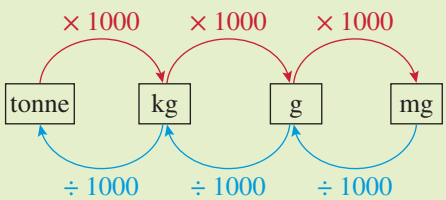
- A **fully simplified fraction** is found by dividing both the numerator and the denominator by the HCF.
  - For example: The HCF of 27 and 36 is 9. $\frac{27 \div 9}{36 \div 9} = \frac{3}{4}$
- A **fully simplified ratio** is found by dividing each part by the HCF.

  18 : 24 (HCF of 18 and 24 is 6.)
  $= 18 \div 6 : 24 \div 6$
  $= 3 : 4$
- Ratios written in simplest form, use whole numbers only.
- Ratios should be expressed in simplest form, as it is a mathematical convention.
- If a ratio is given with one or more fractions, simplify by multiplying each part of the ratio by the LCD. This converts the ratio into whole numbers.

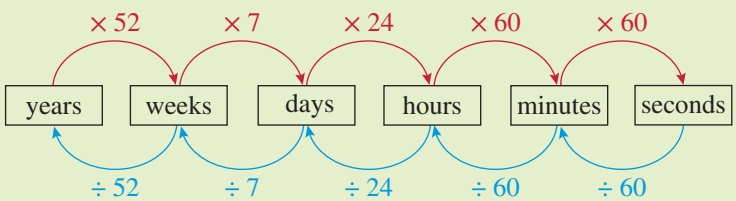
  $\frac{5}{12} : \frac{9}{8} = \frac{5}{12} \times 24 : \frac{9}{8} \times 24$ (LCD of 12 and 8 is 24.)
  $= 10 : 27$
- Ratios should be written in the same units before they are simplified.
- Smaller units $\boxed{\div \text{ factor}}$ to fewer larger units. Larger units $\boxed{\times \text{ factor}}$ to more smaller units.
- Conversion of **length** units



- Conversion of **mass** units



- Conversion of **time** units



- Other unit conversions:
  - 1000 mL = 1 litre
  - 100 cents = $1

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Example 5 Simplifying fractions

Use division to fully simplify these fractions.

a $\frac{12}{15}$ **b** $\frac{88}{55}$ **c** $\frac{7}{21}$

WORKING	THINKING
a $\frac{12 \div 3}{15 \div 3} = \frac{4}{5}$	The HCF of 12 and 15 is 3. Divide both numbers by 3.
b $\frac{88 \div 11}{77 \div 11} = \frac{8}{7}$	The HCF of 88 and 77 is 11. Divide both numbers by 11.
c $\frac{7 \div 7}{21 \div 7} = \frac{1}{3}$	The HCF of 7 and 21 is 7. Divide both numbers by 7.

Example 6 Simplifying ratios

Determine the simplest form of each of the following ratios.

a 15 : 35 **b** 64 : 48 **c** 18 : 27 : 45 **d** $\frac{3}{7} : \frac{2}{3}$ **e** $3\frac{3}{5} : 2\frac{1}{4}$

WORKING	THINKING
a $15 : 35 = 3 : 7$ (÷ 5)	The HCF of 15 and 35 is 5. Divide all parts by 5.
b $64 : 48 = 4 : 3$ (÷ 16)	The HCF of 64 and 48 is 16. Divide all parts by 16.
c $18 : 27 : 45 \xrightarrow{\div 9} = 2 : 3 : 5$	The HCF of 18, 27 and 45 is 9. Divide all parts by 9.
d $\frac{3}{7} : \frac{2}{3} = \frac{3}{7} \times 21 : \frac{2}{3} \times 21$ $= 9 : 14$	The LCM of 7 and 3 is 21. Multiply each fraction by 21.
e $3\frac{3}{5} : 2\frac{1}{4} = 3\frac{3}{5} \times 20 : 2\frac{1}{4} \times 20$ $= 72 : 45$ $= 8 : 5$	The LCM of 4 and 5 is 20. Multiply each fraction by 20. The HCF of 72 and 45 is 9. Divide both parts by 9.

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Example 7 Simplifying ratios with different units

Convert the following ratios to the same unit as shown in the brackets and then determine the simplest form of each ratio.

a 6 m : 300 cm (cm) **b** 1 h : 25 min (min) **c** 40 mL : 12 litres (mL)

WORKING	THINKING
a 6 m : 300 cm = 600 : 300 ÷ 300 = 2 : 1	6 m = 600 cm. When units are the same they are not included in the ratio. The HCF of 600 and 300 is 300. Divide both parts by 300.
b 1 h : 25 min = 60 : 25 ÷ 5 = 12 : 5	1 h = 60 min. Units are not used now. The HCF of 60 and 25 is 5. Divide both parts by 5.
c 40 mL : 12 L = 40 : 12000 ÷ 40 = 1 : 300	12 L = 12000 mL. Units are not used now. The HCF of 40 and 12000 is 40. Divide both parts by 40.

Example 8 Finding the simplest ratio in a real situation

A fuel container has 60 mL of oil and 3 litres of petrol poured into it. Identify the ratio of oil to petrol and then determine the simplest ratio of oil to petrol that is mixed in this fuel can.

WORKING	THINKING
oil : petrol 60 mL : 3 L × 1000 60 mL : 3000 mL 60 : 3000 ÷ 60 1 : 50	Identify the ratio oil : petrol = 60 mL : 3 litres. Convert to the same smaller unit of mL. Write the ratio as whole numbers without units. Simplify the ratio.

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Exercise 1B

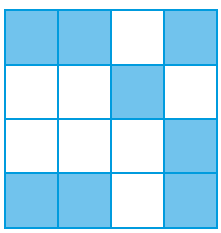
FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in each of the following.

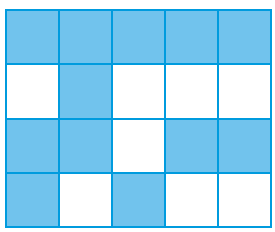
- **a** The highest common factor (_____) is the largest number that divides _____ into two or more numbers.
- **b** A ratio is fully simplified by _____ each part by the _____.
- **c** A fraction is fully simplified by _____ both the numerator and the denominator by the _____.
- **d** The lowest common denominator (_____) is the lowest whole number that is _____ divisible by two or more denominators.
- **e** When a ratio includes fractions, multiply each part of the ratio by the _____.

2 For the diagrams below determine the ratio of shaded parts to unshaded parts, in simplest form.

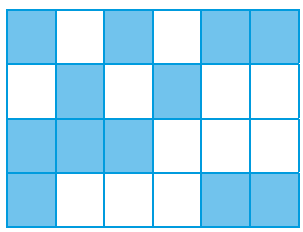
a



b



c



3 Identify which of the following is not written in simplest form and then simplify.

a **i** 1 : 7	**ii** 4 : 22	**iii** 3 : 13	**iv** 5 : 22
b **i** 2 : 31	**ii** 5 : 23	**iii** 13 : 39	**iv** 16 : 61
c **i** 5 : 8	**ii** 7 : 24	**iii** 8 : 3	**iv** 35 : 25

4 Determine the highest common factor (HCF) of these pairs of numbers.

a 10, 15	**b** 21, 28	**c** 15, 24
d 12, 24	**e** 35, 56	**f** 72, 60
g 81, 36	**h** 24, 18	**i** 60, 36
j 66, 88	**k** 70, 105	**l** 75, 125

> **Hint** Knowing your times tables helps with finding the HCF.

Example 5

5 Use division to simplify the following fractions.

a $\frac{5}{10}$	**b** $\frac{3}{12}$	**c** $\frac{6}{18}$
d $\frac{8}{12}$	**e** $\frac{14}{21}$	**f** $\frac{13}{25}$
g $\frac{72}{108}$	**h** $\frac{105}{120}$	**i** $\frac{105}{168}$

> **Hint** Divide both the numerator and the denominator by the HCF.

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Example 6a, b

6 Determine the simplest form of each of the following ratios.

a 2 : 6	**b** 15 : 30	**c** 8 : 24
d 12 : 48	**e** 9 : 15	**f** 12 : 18
g 14 : 35	**h** 15 : 45	**i** 40 : 180
j 68 : 17	**k** 81 : 24	**l** 330 : 550

Hint Divide each part of a ratio by the HCF.

Example 6c

7 Use division by a HCF to simplify the following ratios.

a 5 : 15 : 30	**b** 4 : 16 : 20	**c** 7 : 21 : 35
d 8 : 12 : 18	**e** 21 : 28 : 70	**f** 20 : 45 : 80
g 14 : 35 : 49	**h** 26 : 39 : 52	**i** 100 : 250 : 350

8 Identify the lowest common multiple (LCM) of the following pairs of numbers.

a 2, 3	**b** 5, 7	**c** 8, 12
d 21, 42	**e** 10, 20	**f** 10, 25
g 6, 9	**h** 16, 24	**i** 8, 10

Hint The LCM is the lowest whole number that is exactly divisible by both numbers.

Example 6d, e

9 Calculate the simplest form of each of the following ratios by multiplying both fractions by their lowest common denominator (LCD).

a $\frac{1}{2} : \frac{1}{3}$	**b** $\frac{1}{3} : \frac{1}{4}$	**c** $\frac{2}{5} : \frac{3}{4}$
d $\frac{3}{7} : \frac{2}{3}$	**e** $2\frac{1}{2} : 3\frac{1}{3}$	**f** $3\frac{1}{4} : 2\frac{1}{5}$
g $1\frac{2}{3} : 2\frac{1}{4}$	**h** $5\frac{3}{5} : 7\frac{5}{6}$	**i** $2\frac{1}{2} : \frac{25}{4}$

Hint The LCD is the lowest whole number that is exactly divisible by both denominators.

Example 7

10 Write each ratio in cents and then determine the fully simplified form of each ratio.

a \$3.00 : 40 cents	**b** 50 cents : \$7.50
c \$2.75 : 25 cents	**d** 75 cents : \$4.25
e \$1.80 : \$3.00	**f** \$1.20 : \$4.00

Hint A ratio in simplest form uses whole numbers only and does not include units.

11 Convert the following ratios to the same unit as shown in the brackets, and then determine the simplest form of each ratio.

a 6 hours : 1 day (hours)	**b** 26 weeks : 2 years (weeks)
c 4 weeks : 1 year (weeks)	**d** 26 weeks : 3 years (months)
e 20 hours : 3 days (hours)	**f** 26 weeks : 4 years (years)
g 60 hours : 1 week (hours)	**h** 450 minutes : 2 days (minutes)

12 Convert the following ratios so that both units match the unit shown in the brackets, and then use division to write each ratio in simplest form.

a 25 cm : 12 mm (mm)	**b** 2000 m : 12 km (km)
c 200 m : 4 km (m)	**d** 5 mm : 1.5 cm (mm)
e 2 km : 400 m (m)	**f** 5 m : 30 cm (cm)
g 2000 m : 12 km (km)	**h** 2000 m : 12 km (m)

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APPLICATIONS

SF: 13–23	CF: –	CU: –

Example 8

13 A two-stroke motor has a ratio of 5 mL of oil for every 2 litres of petrol.

- **a** Identify the ratio of oil to petrol.
- **b** Convert the units to mL for both quantities in the ratio.
- **c** Determine the simplified ratio of oil to petrol

Oil and petrol are mixed in a specific ratio for lawn mower fuel.

14 A radio station offers to donate $25 to a charity for every $200 raised by its listeners.

- **a** In simplest form, determine the ratio of the money donated by the station to the money donated by the listeners.
- **b** Express this information as a simplified ratio of money donated by the listeners to money donated by the station.

15 A country real estate agent has a large block of land for sale. The land has a length of $1\frac{3}{4}$ km and a width of $1\frac{1}{6}$ km.

Hint When writing a ratio, follow the order given in the question.

- **a** Rewrite the ratio of length to width, $1\frac{3}{4} : 1\frac{1}{6}$, using improper fractions.
- **b** Determine the lowest common denominator of the fractions in this ratio.
- **c** Multiply by the common denominator to write this ratio in simplest form.

★**16** Old MacDonald had a farm with 42 sheep, 30 cows and 54 chickens. Identify the ratio of the numbers of sheep to cows to chickens, and then determine the simplified form of this ratio.

Hint Start with words and show steps.

★**17** In one week, the local fish and chip shop made the following fish sales: 30 pieces of cod, 45 pieces of flake and 12 pieces of coral trout. Write the numbers of fish sales as a ratio and then determine the simplified ratio.

Hint Start your answer by writing words: cod to flake to trout = …

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★ **18** Research has found that in Central Australia, on a typical hot summer day, the water required by animals greatly varies. A wild camel can consume 200 litres of water; a red kangaroo 200 mL of water; and an emu 15 litres of water. Determine the simplified ratio for the water requirements of a camel to a kangaroo to an emu.

> **Hint** Write the ratio in:
> - words
> - numbers with different units
> - numbers with the same units
> - simplified numbers with no units.

★ **19** Harriett has just landed a new job and her contract states that for every 7 years of work, she will receive 7 weeks of long service leave. Express the ratio of years of work to weeks of long service leave, and then simplify.

> **Hint** Ratios in simplest form are written using whole numbers without units.

20 A school has 105 teachers and 750 students. In simplest form, determine the ratio of teachers to students.

★ **21** Ken is not happy that his children watch so much television. He has promised his children that for every 1.5 hours of home chores completed over the holidays, they are allowed to watch 45 minutes of television. Determine a correct simplified ratio for the ratio of time spent on home chores to television time.

> **Hint** Start with words and include working steps.

★ **22** Jessica is in Year 11 and she has calculated that she has 12 weeks of holidays and attends school for 1344 hours that year. Use this information to determine a simplified ratio that shows the relationship of holidays to school days for Jessica's Year 11.

★ **23** A recipe for muffins for 20 people consists of 5 cups of sugar, 15 cups of flour and 10 eggs.

a Determine the simplified ratio of sugar to flour to eggs.

b Determine how many people the simplified recipe would feed.

Chefs use ratios to scale recipes for different portion numbers.

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1C Equivalent ratios and fractions

LEARNING GOALS

- Calculate equivalent fractions
- Calculate equivalent ratios
- Apply equivalent ratios in real-world situations

Where is it essential to use equivalent ratios?

Equivalent ratios maintain a fixed proportion of components when varying the total quantity. For example, bakers need to follow the same recipe ratio when mixing ingredients for either one loaf of bread or baking many loaves.

Nurses use ratios to calculate dosage.

There are many work situations, as well as for cooking, where people use equivalent ratios to calculate the correct quantities for a mixture. Farmers need to keep fixed proportions when mixing chemicals for fertiliser or poison; tradespeople mix ingredients in certain ratios for concrete or fuel; and jewellers calculate precise quantities of alloys when combining metals. Pharmacists and nurses use ratios to calculate medical dosages. For example, if a doctor orders 750 mg of a drug that has a stock strength of 300 mg/8 mL, then $300 : 8 = 750 : x$, giving the dosage $x = 20$ mL.

WHAT YOU NEED TO KNOW

- When both the numerator and the denominator are multiplied or divided by the same number, the resulting fraction is called an **equivalent fraction**.
  - For example: $\frac{75}{100}$, $\frac{3}{4}$ and $\frac{6}{8}$ are all equivalent fractions.

    $\frac{75 \div 25}{100 \div 25} = \frac{3}{4}$ and $\frac{3 \times 2}{4 \times 2} = \frac{6}{8}$.
- When each value in the ratio is multiplied or divided by the same number, the resulting ratio is called an **equivalent ratio**.
  - For example: 200 : 500 and 2 : 5 and 6 : 15 are all equivalent ratios.

$$\overset{\div 100}{\underset{\div 100}{200 : 500 = 2 : 5}} \qquad \overset{\times 3}{\underset{\times 3}{2 : 5 = 6 : 15}}$$

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Example 9 Calculating equivalent fractions

Use multiplication to complete each of these equivalent fractions.

a $\frac{1}{2} = \frac{5}{\square}$ **b** $\frac{2}{3} = \frac{\square}{18}$ **c** $\frac{5}{7} = \frac{\square}{21} = \frac{35}{\square}$

WORKING	THINKING
a $\frac{1 \times 5}{2 \times 5} = \frac{5}{10}$	$1 \times 5 = 5, 2 \times 5 = 10$
b $\frac{2 \times 6}{3 \times 6} = \frac{12}{18}$	$3 \times 6 = 18, 2 \times 6 = 12$
c $\frac{5}{7} \overset{\times 7}{\underset{\times 7}{\times 3}} = \frac{15}{21} = \frac{35}{49}$	$7 \times 3 = 21, 5 \times 3 = 15$ $5 \times 7 = 35, 7 \times 7 = 49$

Example 10 Calculating equivalent ratios

Use multiplication or division to determine the missing numbers in each of the following equivalent ratios.

a $3 : 7 = 12 : \square$ **b** $8 : 20 = \square : 35$ **c** $3 : 5 : \square = \square : 40 : 80$

WORKING	THINKING
a $3 : 7 \overset{\times 4}{\underset{\times 4}{=}} 12 : 28$	$3 \times 4 = 12$ $7 \times 4 = 28$
b $8 : 20 = \square : 35$ $\div 4$, $\times 7$ $2 : 5 = 14 : 35$ $\times 7$	$20 \times \boxed{?} = 35$. As $\boxed{?}$ is not a whole number, first we must simplify the ratio given on the left. $\frac{8}{4} : \frac{20}{4} = 2 : 5$ $5 \times 7 = 35, 2 \times 7 = 14$
c $3 : 5 : 10 = 24 : 40 : 80$ $\times 8$, $\div 8$ $\times 8$	$5 \times 8 = 40, 3 \times 8 = 24$ $80 \div 8 = 10$

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Example 11 Solving real-world problems using equivalent ratios

a Caterina generally wins two games of cards out of every five games she plays. Identify the ratio of games won to games played, and use this to determine how many games she will need to play to win 12 games.

b Ashley's two-stroke outboard motor requires an oil to petrol mix of 1 : 50. If he has a jerry can with 30 L of petrol, calculate how many millilitres of oil Ashley should add to the jerry can.

WORKING	THINKING
a games won : games played = 2 : 5 = 12 : 30 (× 6) Caterina will need to play 30 games.	games won : games played = 2 : 5 = 12 : ☐ Keep the same order. 2 × 6 = 12, 5 × 6 = 30 Write your answer in words.
b oil : petrol = 1 : 50 = ☐ : 30 (× 600) 1 : 50 = 600 : 30 000 mL (× 600) Ashley will need 600 mL of oil.	oil : petrol = 1 : 50 = ☐ : 30 50 × ☐ = 30 is difficult to solve; hence, convert 30 L to mL. [L(× 1000) → mL] 50 × 600 = 30 000, 1 × 600 = 600 Write your answer using words.

Exercise 1C

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in each of the following.

a Equivalent fractions are found by multiplying or _____ the numerator and the _____ by the _____ number.

b When each value in a ratio is _____ or divided by the _____ number, the resulting ratio is called an _____ ratio.

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Example 9

2 Use multiplication to complete these equivalent fractions.

a $\frac{1}{2} = \frac{\square}{20}$ **b** $\frac{2}{3} = \frac{\square}{21}$ **c** $\frac{7}{8} = \frac{35}{\square}$

d $\frac{4}{7} = \frac{20}{\square}$ **e** $\frac{8}{11} = \frac{\square}{88}$ **f** $\frac{5}{12} = \frac{\square}{36}$

g $\frac{11}{12} = \frac{\square}{24} = \frac{55}{\square}$ **h** $\frac{13}{25} = \frac{\square}{50} = \frac{130}{\square}$ **i** $\frac{2}{7} = \frac{6}{\square} = \frac{\square}{49}$

j $\frac{5}{6} = \frac{\square}{30} = \frac{100}{\square}$ **k** $\frac{7}{12} = \frac{\square}{60} = \frac{49}{\square}$ **l** $\frac{3}{8} = \frac{40}{\square} = \frac{\square}{80}$

3 Demonstrate your understanding of equivalent ratios by writing three equivalent ratios for each of the following.

a 2 : 3 **b** 3 : 5 **c** 11 : 9 **d** 4 : 6 : 8

Example 10

4 Use multiplication or division to complete the following equivalent ratios.

a 1 : 4 = 5 : $\square$ **b** 3 : 5 = $\square$: 30

c 2 : 7 = 8 : $\square$ **d** $\square$: 4 = 6 : 24

e 7 : $\square$ = 21 : 33 **f** $\square$: 9 = 20 : 36

g 12 : 15 = 20 : $\square$ **h** 8 : 20 = $\square$: 35

i 22 : $\square$ = 55 : 100 **j** 3 : 4 : 5 = 9 : $\square$: $\square$

k 3 : 5 : $\square$ = $\square$: 25 : 40 **l** $\square$: 8 : 12 = 12 : 24 : $\square$

m 2 : 3 : 7 = $\square$: 9 : $\square$ **n** 5 : 4 : 1 = 25 : $\square$: $\square$

o $\square$: $\square$: 9 = 21 : 35 : 27

5 **a** Explain why the ratios 2 : 5 and 8 : 11 are not equivalent ratios.

b Determine a ratio that is equivalent to the ratio 2 : 5.

APPLICATIONS

SF: 6–14 | CF: – | CU: –

Example 11

6 David is making his mum's favourite vinaigrette dressing. The recipe uses 3 tablespoons of olive oil and 1 tablespoon of apple cider vinegar. If David is making a larger quantity and is using 12 tablespoons of olive oil, use a calculation involving equivalent ratios to deduce how many tablespoons of apple cider vinegar he should add.

Hint First write: oil to vinegar = … Keep the same order for the number ratio.

7 Lynn has noticed that when she is driving through the city, she gets two red lights for every three green lights. If Lynn was stopped at 10 red lights during her journey, use a calculation involving equivalent ratios to determine how many green lights she passed through.

Hint Start by writing the ratio order in words.

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8 For safety reasons, the recommended nurse to patient ratio is 1 : 4. If there are 32 patients on a particular ward, use equivalent ratios to calculate how many nurses must be working on the ward for the hospital to be compliant with the safety recommendations.

9 Ryan is planning to build a new in-ground spa. His current spa has a diameter to circumference ratio of 1 : 3.14. His new spa will have a diameter of 1.8 m. So that Ryan can plan for the surrounding tiles, use the diameter : circumference ratio to calculate the circumference of the new spa.

Hint Use equivalent ratios to find the solution.

10 When fishing in the Maroochydore River, Isabelle catches four legal-sized fish for every 12 undersized fish, which she has to throw back as they are too small. Using equivalent ratios, determine how many undersized fish Isabelle needed to throw back, if she catches nine legal-sized fish.

Hint Always write your final answer using words.

11 Jonah scored 8 goals and 14 points in a game of Aussie Rules, and his brother Luther scored with the same ratio of goals to points. If Luther scored 21 points, use equivalent ratios to calculate how many goals he scored.

12 Concrete is to be made from a mixture of sand, gravel and cement in the ratio of 4 : 3 : 1. If 10 kg of sand is used, calculate how much gravel will be needed, using equivalent ratios.

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13 Gavin's brush cutter requires a petrol to two-stroke oil mix of 25 : 1. Use equivalent ratios to determine how much oil he must add to his 4 litres of petrol.

★14 Priya has a 48 000 L chlorine swimming pool. The instructions on the liquid chlorine container state that the daily amount required is 400 mL for every 10 000 L of water.
Calculate how much chlorine Priya should add to her pool each day.

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1D Dividing quantities in a given ratio COMPLEX

LEARNING GOALS

- Master the skills of dividing up a quantity into a given ratio
- Solving real-world problems that require dividing a quantity in a given ratio

Who would find it essential to divide up an amount in a given ratio?

Anyone who mixes materials, such as a concreter, a chemist, a cook, a farmer and many other workers, need to divide up an amount in a given ratio. People regularly use ratios to calculate the amount of each ingredient needed to add up to a certain total quantity. Solicitors also use ratios to divide up an inheritance according to the instructions in the will.

Food stock managers for sporting events use proportions to calculate supplies. If three in 25 fans buy pies, then 6300 pies are required for 52 500 fans at Suncorp Stadium.

WHAT YOU NEED TO KNOW

- When dividing up a quantity using a ratio, first calculate the sum of the ratio parts.
  - For example: The ratio 3 : 7 has a sum of $3 + 7 = 10$ parts.
- Dividing (i.e. sharing) an amount using ratios is made simpler using fractions.

  $$\text{Proportion or fraction of the total amount} = \frac{\text{one part of a ratio}}{\text{sum of ratio parts}}$$

  - For example: To share \$200 in the ratio of 3 : 7 means $\frac{3}{10} \times 200 : \frac{7}{10} \times 200$, which gives \$60 and \$140 as the two shares.

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Example 12 Dividing quantities in a given ratio

For each of the following, calculate the total number of parts in the ratio. Then use appropriate proportions (fractions) to divide the quantity into this ratio.

a $3600 in the ratio of 2 : 7 **b** 420 kg in the ratio of 1 : 2 : 4

WORKING	THINKING
a $2 + 7 = 9$	Sum of parts $= 2 + 7 = 9$
$\frac{2}{9} \times 3600 = 800$	Proportions (i.e. fractions) are $\frac{2}{9}$ and $\frac{7}{9}$.
$\frac{7}{9} \times 3600 = 2800$	
$800 and $2800	Write units in the final amounts.
b $1 + 2 + 4 = 7$	Sum of parts $= 1 + 2 + 4 = 7$
$\frac{1}{7} \times 420 = 60$	Proportions (i.e. fractions) are $\frac{1}{7}$, $\frac{2}{7}$ and $\frac{4}{7}$.
$\frac{2}{7} \times 420 = 120$	
$\frac{4}{7} \times 420 = 240$	
60 kg, 120 kg and 120 kg	Write units in the final amounts.

Example 13 Dividing a quantity in a given ratio to solve a real-life situation

Jasmine found an old piece of jewellery weighing 176 grams. It is a mixture of gold and nickel in the ratio 3 : 8. Calculate the weight of the gold in this jewellery piece.

WORKING	THINKING
Total weight = 176 g	Summarise the information from the question.
Gold : nickel = 3 : 8	Write the ratio in words and numbers, keeping the same order as in the question.
Gold $= \frac{3}{11} \times 176 = 48$	Sum of parts $= 3 + 8 = 11$
	Gold proportion $= \frac{3}{11}$
There is 48 grams of gold.	Write your answer in words, using units.

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Exercise 1D

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in each of the following.

a When dividing up a quantity using a ratio, first calculate the _____ of the _____ parts.

b Each proportion of the total amount = $\frac{\square \text{ part of a ratio}}{\square \text{ of the ratio parts}}$.

c When dividing up a quantity using a ratio, each share = _____ × _____.

2 Calculate the sum of the parts in these ratios.

a 1 : 5 **b** 3 : 5 **c** 9 : 11 **d** 3 : 5 : 7

3 At the local skate park, the ratio of bike riders to scooter riders is 3 : 7. Determine the fraction of the riders that are:

Hint First calculate the sum of the ratio parts.

a bike riders

b scooter riders

4 A jar contains jelly beans and snakes in the ratio 5 : 6. Determine the fraction of the lollies that are:

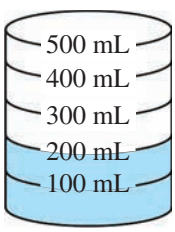
a snakes **b** jelly beans

5 A litter of new kittens has ginger and tortoise shell colours in the ratio 2 : 5. Determine the fraction of the litter that is:

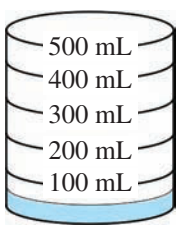
a ginger coloured **b** tortoise shell coloured

6 When completely full, each container holds 500 mL.

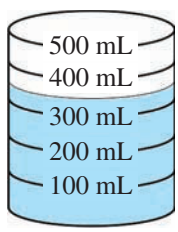
a



b



c



For each container calculate the simplified ratio of volume of liquid to volume of the full container.

Example 12

7 Calculate the total number of parts in the given ratio. Then use appropriate proportions (fractions) to divide $100 in the ratio of:

Hint Start by finding the total parts.

a 1 : 9 **b** 1 : 3 **c** 3 : 7 **d** 2 : 5

8 Calculate the total number of parts in the given ratio. Then use appropriate proportions (fractions) to divide $1200 in the ratio of:

a 1 : 2 **b** 1 : 5 **c** 5 : 7 **d** 7 : 3

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9 Calculate the total number of parts in the ratio. Then use appropriate proportions (fractions) to divide each of the following in the ratio given.

Hint: $\frac{\text{ratio part}}{\text{total of parts}} \times \text{amount}$

a \$40 in the ratio 1 : 3
b \$90 in the ratio 1 : 2
c \$150 in the ratio 2 : 3
d \$220 in the ratio 4 : 7
e 32 kg in the ratio 3 : 5
f 450 kg in the ratio 7 : 2
g 48 litres in the ratio 5 : 7
h 132 litres in the ratio 8 : 3
i 200 g in the ratio 4 : 1
j 49 lollies in the ratio 5 : 2

10 Calculate the total number of parts in the ratio. Then use appropriate proportions (fractions) to divide each of the following in the ratio given.

Hint: Remember your final answer needs units.

a \$300 in the ratio 1 : 2 : 3
b 270 kg in the ratio 2 : 3 : 5
c 64 000 litres in the ratio 1 : 3 : 4
d \$1 250 000 in the ratio 12 : 8 : 5
e 300 m in the ratio 3 : 3 : 4
f 80 chocolates in the ratio 1 : 4 : 3
g 180 plants in the ratio 10 : 5 : 3
h \$1500 in the ratio 20 : 7 : 3

APPLICATIONS

SF: – | CF: 11–19 | CU: 20–22

Example 13

11 Graham and Jean run a sheep farm and, after breeding season, they have calculated that the ewe to lamb ratio is 20 : 19. They currently have a total of 5265 sheep on their property.

Hint: First write the ratio order in words. Keep the same order for the numbers.

a Calculate the total number of parts in the ratio.
b Determine what fraction of the sheep are ewes and what fraction are lambs.
c Calculate how many ewes and lambs they have in total.

12 During the wet season in Cairns, it rains five days for every four sunny days. The wet season runs for a total of 90 days.

a Identify the ratio of rainy days to sunny days.
b Calculate the total number of parts in the ratio.
c Determine what fraction of days are sunny.
d Calculate how many sunny days there are during the wet season.

Barron Falls, Kuranda

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13 In one year recently, there were 2170 accidents on Queensland's roads. Use the ratio of fatal to non-fatal accidents of 1 : 9 to:

- **a** Calculate the total number of parts in the ratio.
- **b** Determine what proportion of accidents were fatal and the proportion of accidents that were non-fatal.
- **c** Calculate how many accidents were fatalities compared to non-fatalities.

14 Ariana, Kacey and Sarah inherited $55 000 from their grandmother, who left them an inheritance in the ratio of 5 : 4 : 2, respectively.

- **a** Use this ratio to explain who gets more of the inheritance.
- **b** Calculate the total number of parts in this ratio.
- **c** Determine what fraction of the profit inheritance Ariana receives.
- **d** Determine what fraction of the profit Sarah receives.
- **e** Use your answer to part **c** to calculate Ariana's share of the inheritance.
- **f** Use your answer to part **d** to calculate Sarah's share of the inheritance.
- **g** Use your answers to parts **e** and **f** to determine how much more Ariana will receive than Sarah.

Hint Write your final answer to part g in words, using units.

15 Cassie, Jarred, Andrew and Anneliese went to the movies and Jarred decided to pay for Cassie and Anneliese, as well as his own ticket. All four tickets cost $56.

- **a** Use the information to write down how many tickets Jarred paid for and how many Andrew paid for.
- **b** Write the ratio of Jarred's tickets to Andrew's tickets.
- **c** Use this ratio to calculate how much Jarred paid.

★16 Megan and Luke own a coffee shop together. They split the profits in the ratio 5 : 4. If the shop made a profit of $114 732 in one year, calculate how much money Megan and Luke each receive.

★17 Brock, Jasper and Ruth win a 1 kg block of chocolate, which they split in the ratio 1 : 2 : 3. Calculate how many grams of chocolate each individual receives.

Hint 1 kg = 1000 g

★18 Great Aunty Rose passed away and left her inheritance in the ratio of 1 : 1 : 3 to her sisters Gretel, Helga and Marie, respectively.
Marie cared for Aunty Rose in her last few years and this is why she has the larger share. Rose's estate is worth $600 000; this is the total amount of inheritance that her sisters will receive. Calculate how much each sister would receive.

Hint The word 'respectively' means in the same order.

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★ **19** Melanie is organising the cordial drinks for the end-of-year function.

a If the ratio of cordial to water is 2 : 18, respectively, calculate the amount of cordial and water that is needed to fill a 50 litre drink dispenser.

b Calculate the total cost of purchasing the cordial, if it costs $2.55 per 2 L bottle of cordial.

★ **20** Brooke runs a local hair salon and she wants to calculate the cost price for one hair colouring procedure. The mixture she makes has a 2 : 1 ratio of developer to colour.

a Brooke estimates that she needs around 450 mL of mixture to colour long hair. Use the ratio given to calculate how many millilitres of developer Brooke would need.

b The developer costs $3 per 100 mL and the colour costs $2 per 100 mL. Determine the cost price of the products for one long hair colouring procedure.

Hairdressers use ratios in their daily work.

21 Ezekiel is concreting his driveway and has worked out that it will take 9 cubic metres (m^3) of concrete mix to make his driveway. The concrete mix ratio is 1 : 2 : 3 of cement to sand to gravel, respectively.
Cement costs $150 per m^3, sand costs $60 per m^3 and gravel costs $80 per m^3. Calculate the cost of materials for Ezekiel's driveway.

Concrete is made from cement : sand : gravel mixed in a specific ratio.

22 Olivia is splitting chocolate between her Maths and English teachers in the ratio of 3 : 2. (Maths is her favourite subject.) Olivia's Maths teacher receives 900 g of chocolate. Calculate how many grams of chocolate Olivia gives to her teachers, in total.

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1E Scale values using ratios COMPLEX

LEARNING GOALS

- Convert a scale distance to an actual distance
- Convert an actual distance to a scaled distance
- Determine scale ratios
- Finding the actual and scaled distances from real-world problems

When would it be essential to use scale values?

Scale models and scale drawings are used to find design errors and improvements for inventions, new designs (e.g. cars, buildings) and engineering projects.

A map is a scale copy of the landscape. The scale on a map or a house plan can be used to calculate actual distances.

Professional model makers in Queensland use scale ratios to build architectural and engineering models for commercial and government use.

WHAT YOU NEED TO KNOW

- A **scale drawing** or **model** has exactly the same shape as the actual object but it is a different size. The scale ratio should be included with a drawing or model.
- The **scale** on a drawing, diagram, map or model is written as a scale ratio.
  Scale ratio = drawing (or model) length : actual length
- A scale ratio of 1 : 100 = drawing (or model) : actual means that the actual (real life) lengths are 100 times larger than the drawing lengths.
  - For example: A house plan scale of 1 : 100 means that 2 cm on the plan = 200 cm in real life.
- A scale ratio of 100 : 1 = model : actual means that the model lengths are 100 times larger than the actual object. (100 : 1 = 1 : 1/100)
  - For example: If a plastic model of a plant cell has scale 100 : 1, then 1 cm on the model = $\frac{1}{100}$ cm in the actual plant cell.
- The **scale factor** is the second number in a scale ratio that starts with 1.
  - For example: For the scale 1 : 1000, the scale factor is 1000.

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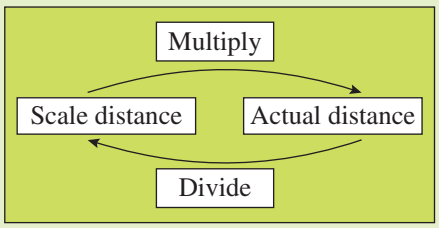
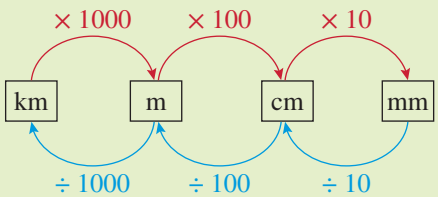
- To convert a scaled length to the actual length, multiply by the scale factor.
- To convert an actual length to the scaled length, divide by the scale factor.



It is important to accurately **convert length units** when calculating with scales.



Example 14 Converting a scale distance to an actual distance

A map has a scale of 1 : 50000.
Use the given scale to calculate the actual distance for the each of the following scaled distances.

a 6 cm **b** 150 mm **c** 2.75 cm

WORKING	THINKING
a Actual distance $= 6\text{ cm} \times 50000$ $= 300000\text{ cm}$ $= 3000\text{ m}$ $= 3\text{ km}$	Multiply 6 cm by the scale factor of 50000 and always keep the same units after multiplying by the scale factor (i.e. keep cm). Then convert cm to km, which is a more suitable unit. [cm (÷ 100) → m (÷ 1000) → km]
b Actual distance $= 150\text{ mm} \times 50000$ $= 7500000\text{ mm}$ $= 7500\text{ m}$ $= 7.5\text{ km}$	Multiply 150 mm by the scale factor of 50000, giving an answer in mm. Then convert mm to m to km. [mm (÷ 1000) → m (÷ 1000) → km]
c Actual distance $= 2.75\text{ cm} \times 50000$ $= 137500\text{ cm}$ $= 1375\text{ m}$ $= 1.375\text{ km}$	Multiply 2.75 cm by the scale factor 50000 to give an answer in cm. Then convert cm to m to km. [cm (÷ 100) → m (÷ 1000) → km]

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Example 15 Converting an actual distance to a scaled distance

A suburban development plan has a scale of 1 : 2000.
Use the given scale to calculate the scaled distance for the following actual distances.

a 60 m **b** 250 cm **c** 1.24 km

WORKING	THINKING
a Scaled distance = 60 m ÷ 2000 = 6000 cm ÷ 2000 = 3 cm	The scale 1 : 2000 shows a scale factor of 2000. Convert 60 m to 6000 cm, as 6000 is more easily divided by 2000. [m (× 100) → cm] Divide 6000 cm by 2000 and keep the units in cm.
b Scaled distance = 250 cm ÷ 2000 = 2500 mm ÷ 2000 = 1.25 mm	Convert 250 cm to 2500 mm, as 2500 is more easily divided by 2000. [cm (× 10) → mm] Divide by the scale factor of 2000.
c Scaled distance = 1.24 km ÷ 2000 = 1240 m ÷ 2000 = 0.62 m = 62 cm	Convert 1.24 km to 1240 m, as 1240 is more easily divided by 2000. [km (× 1000) → m] Divide 1240 m by 2000 and keep the units in m. Convert 0.62 m to cm. [m (× 100) → cm]

Example 16 Determining scale ratios

Determine the scale ratio for a map scale when a map length of 12 cm represents an actual distance of 36 km.

WORKING	THINKING
Scale ratio = 12 cm : 36 km = 12 cm : 3 600 000 cm = 12 : 3 600 000 = 1 : 300 000	Scale ratio = drawing length : actual length Include the units for both distances. First convert both lengths to the same units, then write the scale ratio without units. [km (× 1000) → m (× 100) → cm] HCF = 12; hence, divide both ratio parts by 12.

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Example 17 Finding the height of a model from a real-life measurement

The TV transmission towers in Brisbane are approximately 200 m in height.

a Use an appropriate calculation to write this height in centimetres.
The tower height is reduced using a scale of 1 : 500 to make a scale model.

b Identify which number in this ratio represents the actual height of the tower.

c Use the scale to calculate the height of the model tower.

WORKING	THINKING
a $200\text{ m} = 200 \times 100\text{ cm}$ $= 20000\text{ cm}$	1 m = 100 cm
b 500 represents the height of the tower.	1 : 500 = model : actual tower
c Model tower height $= 20000\text{ cm} \div 500$ $= 40\text{ cm}$	The tower is *larger* than the model, so *divide* by the scale factor to find the model height.

Example 18 Finding the actual and scaled distances from a real-life situation

a A scale model of an Indigenous bark canoe is 20 cm long. If it was built at a scale of 1 : 15, calculate the length of the actual canoe in cm and m.

b The beach on Fraser island is 120 km long. Calculate the scaled map distance of this beach on a map that has a scale ratio of 1 : 1 000 000.

WORKING	THINKING
a Actual length $= 20\text{ cm} \times 15$ $= 300\text{ cm}$ $= 3\text{ m}$ The canoe is actually 3 m long.	The actual canoe is *larger* than a model. So *multiply* the scale factor to give 300 cm. Then convert cm to m. [cm (÷ 100) → m] Answer the question in words.

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b 120 km = 120 000 m

Scaled distance = 120 000 m ÷ 1 000 000
= 0.12 m
= 12 cm

The map distance will be 12 cm.

First convert km to m for easier division.
A map is *smaller* than the real beach, so *divide* 1 200 000 m by the scale factor; the answer will also be in m.
Then convert 0.12 m to cm as sensible map measurement units.
[m (× 100) → cm]
Answer the question in words.

Exercise 1E

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in each of the following.

a Scale ratio on a drawing = _____ length : _____ length.

b A house plan with scale 1 : 100 means __ cm on the plan is _____ ___ on the house.

c The scale factor is the _____ number in a ratio that starts with 1.

d A drawing length is _____ than the actual distance, so _____ the drawing length by the scale factor to find the actual distance.

e An actual length is _____ than a drawing length, so _____ the actual length by the scale factor to find the drawing length.

Example 14

2 Use the given scale to calculate the actual distance for each of the scaled distances. Give you answer in appropriate units.

Hint Multiplying by a scale factor does not change the units.

a Scale 1 : 20 000

i 5 cm **ii** 150 mm **iii** 22 cm

b Scale 1 : 50 000

i 3 cm **ii** 200 mm **iii** 15 cm

c Scale 1 : 4000

i 50 mm **ii** 25 cm **iii** 1.6 cm

d Scale 1 : 2500

i 18 cm **ii** 2.75 cm **iii** 22.5 cm

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Example 15

3 Use the given scale to calculate the scaled distance for the each of the actual distances.

Hint A scaled distance is *smaller* than the actual distance, so *divide* by the scale factor.

a Scale 1 : 100

i 500 m **ii** 3000 mm **iii** 2 km

b Scale 1 : 300

i 18 m **ii** 6 km **iii** 21 m

c Scale 1 : 20000

i 4 km **ii** 200 m **iii** 14 km

d Scale 1 : 5000

i 30 m **ii** 2.5 m **iii** 3.75 km

Example 16

4 Determine the scale ratio for each of the following.

Hint Start with drawing length : actual length, including the units.

a A length of 24 mm on a scale drawing represents an actual distance of 4800 cm.

b A length of 15 cm on a scale drawing represents an actual distance of 30 km.

c A length of 2.5 mm on a scale drawing represents an actual distance of 75 km.

d A length of 75 cm on a scale drawing represents an actual distance of 900 m.

e An actual length of 5550 m is represented by 37 cm on a scaled drawing.

f An actual length of 5376 cm is represented by 38.4 mm on a scaled drawing.

5 A map has a scale of 1 : 20000. Use this scale to calculate how many centimetres in real life is represented by a length of 2 cm on the map.

Hint The real distance is *greater* than a map distance, so *multiply* by the scale ratio.

Example 17

6 A car is 5 metres long.

a Use an appropriate calculation to write this length in centimetres.

A scale model of the car is to be built using a scale of 1 : 50.

b Identify which number in the ratio represents the actual length of the car and explain why.

c Use the scale to calculate the length of the model car.

7 An apartment tower is 90 metres tall.

a Use an appropriate calculation to write this length in centimetres.

Using a scale of 1 : 500, the tower is reduced to make a scale model.

b Identify which number in this ratio represents the actual height of the tower.

c Use the scale to calculate the height of the model tower.

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APPLICATIONS

SF: –	CF: 8–15	CU: 16–18

Example 18a

8 A Gold Coast developer plans to build a new high-rise apartment tower. She has a model tower built to a scale of 1 : 2000. The model is 18 cm tall with a square base of side length 4 cm.

- **a** Use the scale to calculate the actual side length of the base of the building.
- **b** Use division to convert this measurement to metres.
- **c** Use the scale to calculate the actual height of the building, in centimetres.
- **d** Use division to convert this measurement to metres.
- **e** If each floor level is 3 m tall, determine how many floors there are in this building.

9 The HMS *Endeavour* commanded by Captain Cook had a length of 30 m. A model of this ship is built to a ratio of 1 : 40.

- **a** Explain why you would divide by 40 to calculate the length of the model ship.
- **b** Calculate the model length, in metres.
- **c** Use multiplication to convert the model length to centimetres.
- **d** Cook's cabin on the HMS *Endeavour* was around 1 m wide by 2 m long. Convert these dimensions to centimetres and then calculate the length, width and floor area for Cook's cabin on this model.

James Cook's apprenticeship studies included maths, navigation and astronomy.

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10 **a** A scale model of a caravan is to be created. Explain why a scale of 1 : 50 would be more appropriate to use than a scale of 1 : 10000.

b A scale model of a city is to be created. Explain why a scale of 1 : 10000 would be more appropriate to use than a scale of 1 : 500.

Example 18b

11 The McLaren P1 racing car is 4.588 m long. A detailed scale model of this car has been built to a scale of 1 : 14.

a Calculate the length of the model, in metres.

b Use multiplication to convert this length of the scale model to millimetres.

Hint The model length is *smaller* than the real length, so *divide* by the scale ratio.

12 Refer to this map of Australia and answer the questions.

a Use a ruler to measure the 0 to 500 km scale, in millimetres.

b Use your result from part **a** to determine how many millimetres on the map represents an actual distance of 100 kilometres.

c Use a ruler to measure the direct distance between Brisbane and Cairns, in millimetres.

d Use your answer from part **b** to estimate the actual direct distance from Brisbane to Cairns, correct to the nearest 100 kilometres.

e Use a ruler to measure the direct distance between Brisbane and Perth, in millimetres.

f Use your answer from part **b** to estimate the actual direct distance from Brisbane to Perth, correct to the nearest 100 kilometres.

g Use the scale to estimate the actual direct distance from Broome to Sydney.

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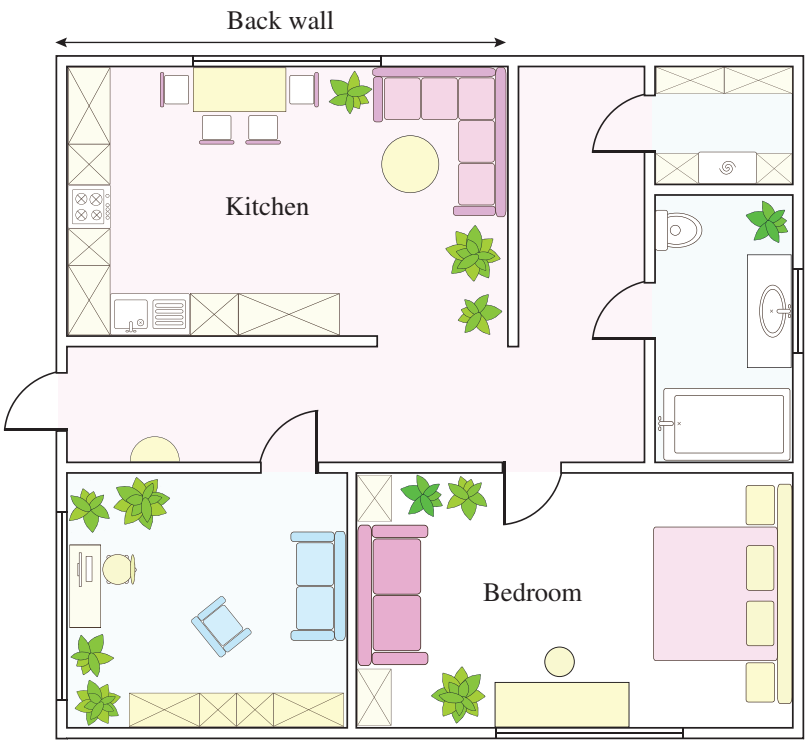
13 In the unit plan shown, the back wall of the kitchen is 4 m long.

a Determine an appropriate scale for this unit plan.

b Use this scale to find the dimensions of the bedroom.

c Calculate the area of the actual bedroom floor.

d Carpet costs \$66 per m^2 laid. Calculate how much it will cost to carpet the bedroom.



14 Queensland's open-cut mines require huge dump trucks. The mining truck shown has a vertical height of 7.37 m (measured at the front left).

a Convert the vertical height of the mining truck to centimetres.

b Use a ruler to measure the height of the truck in the photo at the front left, in centimetres.

c Use your answers to parts **a** and **b** to calculate the scale for this photo.

d Use your ruler to measure the diameter of the front tyre of the truck in the photo.

e Use the scale to calculate the diameter of the front tyre of the actual truck, correct to the nearest 10 cm.

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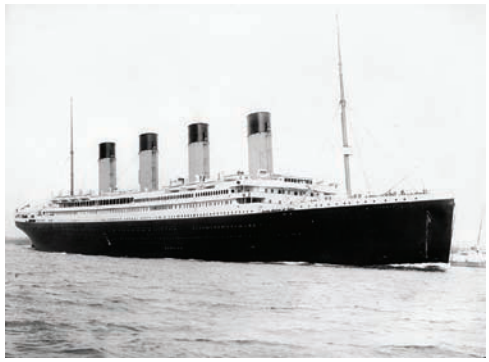

★**15** Sam has found a model of the RMS *Titanic* for sale, which is advertised as having a scale of 1 : 570. The actual RMS *Titanic* had a total length of 269.1 m, a maximum width of 28.2 m and a maximum height of 53.3 m. Calculate the length, width and height of the model.

★**16** Rachel has built a model of her family house. The model is 32 cm long, 24 cm wide and has a height of 9 cm. Rachel's actual house is 16 m long, 12 m wide and 4.5 m high. Determine the scale ratio for the model, in simplified form.

★**17** The photograph shown is of Ben Dover, who is 1.9 metres tall in real life. Determine the scale for the photograph and then use this scale to calculate the height that the dog appears to be in the sitting position.

★**18** Julie owns a block of land that is 24 m by 36 m. She is planning to build a rectangular house that is 12 m by 18 m but she is struggling to decide where to position the house on the land.

The council requires a 6 m setback from the street frontage (i.e. the house must be built at least 6 m back from the front of the block) and a minimum of 2 m space between all sides (left, right and back) and the edges of the block.

A scale of 1 : 120 will be used to draw a scale plan of the block and the outside of the rectangular house.

a Use all of the information to design a plan for where Julie's house should be situated on the block.

b Justify your placement of the house in its position on the plan.

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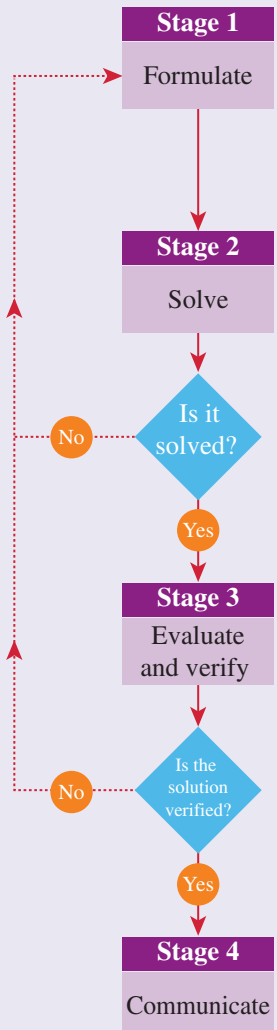
Problem-solving and modelling task

CREATING A SCALE MODEL OF A CAR

Background: Scale models are used in the car industry to develop new designs.

Task: Your task is to construct a scale model of a car of your choice. You can do this in the form of a drawing or with the use of clay or plasticine. You will need measuring tape, rulers and either grid paper, modelling clay or plasticine.

To complete this task, follow the problem-solving workflow diagram below and use the steps listed as a guide.



Stage 1: Formulate

1. Decide on the car you will use to make your scale model.
2. Decide on the maximum size of your model.
3. Decide what measurements on the car will be needed (e.g. various heights, lengths, widths, wheel diameter, etc.).

Stage 2: Solve

4. Create an appropriate scale to use (e.g. 5 cm = 100 cm).
5. Obtain measurements of the actual real car for which you are creating a model.
6. Use your scale to calculate measurements for the scale model.
7. Make your scale model using pencil and grid paper, or with modelling clay/plasticine.

Stage 3: Evaluate and verify

8. Compare your model with the actual car. Which parts of your model look correct? Which parts do not? Revisit steps in stage 1 (Formulate) and stage 2 (Solve) to make adjustments to your model.
9. Does your model now look in proportion to the actual car?

Stage 4: Communicate

10. Communicate your findings in a short report, outlining the decisions involved in making your model, how you adjusted your model, and the calculations you used along the way.

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Puzzle

Mechanics are problem solvers. They use various tools, diagnostic tests and their own intuition and experience to put the clues together and identify the faults with the engine they are working on.

An interesting automechanical fact can be found by solving the puzzle on this page. Answer the questions and use the answer to fill in the letters in the grid below.

Mechanics working on a plane engine

Calculate the missing values in the following equivalent ratios.

A $3 : 7 = \square : 56$ **B** $\square : 9 = 16 : 36$ **C** $4 : 7 : 11 = 28 : \square : 77$

Determine the highest common factor (HCF) of each of the following pairs of numbers.

D 12, 30 **E** 48, 80

Use division to simplify the following fractions.

F $\frac{30}{42}$ **G** $\frac{75}{135}$

Use what you have learned to simplify each the following ratios.

H $\frac{3}{7} : \frac{5}{8}$ **I** $2\frac{4}{5} : 1\frac{3}{4}$ **J** 24 : 36

K 12 : 18 : 21 L **L** 25 mm : 50 cm **M** 30 mL : 4.5 L

For each of the following, calculate the size of each part when the quantity is divided in the given ratio.

N 175 in the ratio of 3 : 4 **O** 175 in the ratio of 2 : 5

P Determine the scale ratio when a length of 6 cm on a scale drawing represents an actual distance of 30 m.

75 : 100	$\frac{5}{9}$	16

$\frac{5}{7}$	24 : 35	1 : 20	1 : 150	75 : 100

50 : 125	24 : 35	56 : 35	6	1 : 150	49	1 : 20	16	16	56 : 35

50 : 125	24 : 35	4 : 6 : 7	16	1 : 20	1 : 150

50 : 125	16	1 : 20	16

2 : 3	4 : 6 : 7	16	1 : 20	24	75 : 100	16	6

4	1 : 500

$\frac{5}{9}$	24	56 : 35	6

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Chapter checklist

☐ I understand the fundamentals of ratios and their relationship with fractions.

1 Write $\frac{5}{9}$ as a ratio.

2 Express 21 : 17 as fractions.

3 Express 8 apples to 11 oranges as a ratio.

☐ I can demonstrate my understanding of ratios.

4 Complete the equivalent ratio 20 : 36 = 30 : ☐.

5 If the oil to fuel ratio for an outboard motor is 1 : 25, calculate how much oil is needed for 5 litres of petrol.

☐ I can express a ratio in simplest form using whole numbers.

6 Use division to simplify the ratio 28 : 35.

7 Use division to simplify the ratio 18 : 30 : 48.

8 Write the ratio $\frac{4}{7} : \frac{3}{5}$ so that the fractions have a common denominator, and use this to simplify the ratio.

☐ I can determine the ratio of two quantities in simplest form.

9 Convert the ratio 15 cm : 3 m to have the same units, and then use division to simplify.

10 Convert the ratio 20 weeks : 2 years to have the same units, and then use division to simplify.

11 A gardener uses 15 mL of pesticide for every 1 litre of water. Identify the ratio of pesticide to water, then write this as a simplified ratio.

☐ I can divide a quantity into a given ratio [Complex].

12 Divide 630 kg in the ratio 4 : 5.

13 Uncle John leaves $200 000 000 to be split in the ratio 5 : 7 : 8 to his nephews Logan, Lucas and Luther. Determine how much Luther receives.

☐ I can use a ratio to describe a simple scale [Complex].

14 Determine the scale ratio when a length of 30 mm on a scale drawing represents an actual distance of 4.5 m.

15 A developer wishes to create a model of a sample house. The house is 15 m wide, 21 m long and 3 m tall. Calculate the dimensions (width, length and height) of the model, using a scale of 1 : 50.

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Chapter Review

All questions in the Chapter Review are assessment-style.

Simple Familiar

Section 1A

1 During one year it rained for 73 days and it was dry on all the other days. Determine the ratio of rainy days to dry days for that year.

2 Mark is a bartender and mixes 30 mL of rum with 240 mL of ginger ale. Determine the ratio of rum to ginger ale, in simplest form.

Section 1B

3 A swim school has 7 teachers and 56 students. In simplest form, determine the ratio of teachers to students.

Section 1C

4 Robyn does twice as much cardiovascular exercise as weights in the gym. Interpret this information by writing it as a ratio. Determine the equivalent ratio if she does 30 minutes of cardio exercise.

5 A local dam is stocked with three types of fish, catfish, yellowbelly and barramundi, in the ratio 2 : 12 : 15. The dam is emptied and all the fish are relocated, of which 24 are catfish.

a Use the ratio to calculate how many yellowbelly you would expect to be relocated.

b Use the ratio to calculate how many barramundi you would expect to be relocated.

6 Lads Landscapes Supplier has 14 cubic metres of garden soil consisting of 4 cubic metres of fertiliser to 10 cubic metres of ordinary soil.
If it wishes to make some more garden soil and it has 22 cubic metres of fertiliser, how much ordinary soil does the company need to mix in with the fertiliser to maintain the same mixture?

7 Martha is a great tennis player and has won 42 games and lost 18 games so far in her career. If Martha wins 105 games in the next 3 years, calculate how many games you would expect her to have lost if she maintains her win : loss ratio.

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Complex Familiar

Section 1D

8 Moo Moo Milk Company produces 5600 bottles of flavoured milk per day, producing five chocolate for every three iced coffee and two strawberry milk.

- **a** Calculate how many more bottles of chocolate milk than strawberry milk are made each day.
- **b** Determine how many more bottles of chocolate milk than strawberry milk will be produced in a standard year.

9 Grace and Lilly both put money into their superannuation for their retirement. Grace saves $120 for every $90 that Lilly saves. After 10 years of saving, they have $109 200 in total. Calculate how much each has saved.

10 The Grade 11 students have won 25.2 kg of lollies in a competition making up an advertising slogan for the Honey Sweetie confectionary company. There are 45 boys and 60 girls. If each student receives an equal share, calculate how many kilograms of lollies the girls will receive.

Complex Unfamiliar

Section 1E

11 Sam has a scale model of a container ship with a ratio of 1 : 200. His model is 1.6 m long. Calculate the length of the actual ship.

12 Igor wants to make a scale model of a skateboard ramp to show his parents what he would like to build in the backyard. The actual ramp is to be 8 m long and 3 m tall. Decide on an appropriate scale for his model if it is to have a maximum length of 50 cm and, hence, calculate the dimensions of Igor's model. Show all your working.

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2 Rates

Maths for a nurse: Alana Phillips

Alana Phillips has been a nurse for 10 years. From a very young age she was determined to become a nurse and help people in need. She commenced her nursing career at Royal Childrens Hospital, Herston before transferring to the Sunshine Coast and working in the Oncology unit. Alana is now a clinical nurse consultant in cancer care. She provides support to individuals and their families who are going through cancer treatment.

Tell us a bit about your job. What does a typical day look like?

I work at a tertiary hospital as a clinical nurse consultant in cancer care. I work closely with the doctors when they do their ward round, ensuring safe delivery of health care is provided. I ensure that patients have follow-up appointments with their treating doctor and that the patient and their family understand treatment goals. I also work closely with ward nurses, providing education to them regarding cancer care, treatment options and interpersonal skills to assist with difficult conversations.

What maths did you study in school?

I completed Maths A at school. I felt that it was the more practical subject that provided me with real-world maths that I would use on a daily basis.

How do you use maths in your job? Could you give some examples?

Maths plays a significant role in my workplace, as a large component of being a nurse is to provide medication to help a patient to get better. This involves calculating the dose of medicine that should be given, as well as the rate of administration for intravenous medications. Percentage calculations are also used on a daily basis.

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In this chapter

2A Understanding rates

2B Converting units

2C Solving problems using rates and direct proportion **[complex]**

2D Comparisons using rates and determining best value

Problem-solving and modelling task

Puzzle

Chapter Checklist

Chapter Review

Syllabus reference

Unit 1 Topic 1 Rates (6 hours)

In this subtopic students will:

- review identifying common usage of rates, including km/h
- convert between units for rates
- complete calculations with rates, including solving problems involving direct proportion in terms of rate **[complex]**
- use rates to make comparisons
- use rates to determine costs.

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Pre-test

1 Solve the following questions.

a $360 \div 3$
b $120 \div 60$
c $3 \div 9$
d $9 \div 36$
e $56 \div 7$
f $4 \div 8$

2 Simplify the following fractions.

a $\frac{25}{50}$
b $\frac{39}{13}$
c $\frac{6}{14}$
d $\frac{45}{21}$
e $\frac{5}{9}$
f $\frac{18}{27}$

3 In each pair of fractions, which is the larger one?

a $\frac{15}{6}$ or $\frac{8}{3}$
b $\frac{7}{9}$ or $\frac{5}{7}$
c $\frac{11}{17}$ or $\frac{9}{13}$

4 What does each of the following units measure?

a centimetres (cm)
b dollars ($)
c seconds (s)
d litres (L)
e kilograms (kg)
f degrees Celsius (°C)

5 Convert the following measurements to the units shown in the brackets.

a 3600 mL (L)
b 132 km (m)
c 270 minutes (hours)
d 5.5 years (days)
e $65 (cents)
f 14 000 g (kg)

6 Give two units of measurements that can be used to calculate the following.

a speed
b fuel usage
c cost of oranges

A link to a HOTmaths lesson is provided in the Interactive Textbook to revise this topic.

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2A Understanding rates

LEARNING GOALS

- Identify a rate
- Determine suitable units for common rates
- Write rates and simplify them
- Calculate average rates of change
- Apply rates in real-life situations

Why are rates essential?

Rate measurements and calculations provide important information for many choices and plans made in our day-to-day lives. For example, using your pay rate ($/hour) to predict income over longer periods; comparing a vehicle's rate of movement (km/h) to the speed limit; applying the rate at which a car uses fuel (litres/100 km) to calculate range and fuel cost; considering the rate of data download charge ($/GB) when choosing a data plan; and reading the rate of energy per serving on product labels (kJ/100 g) when choosing brand and/or portion size.

Comparing fuel efficiency rates (i.e. litres per 100 km) is an important consideration when choosing a car.

WHAT YOU NEED TO KNOW

- **Rates** show the relationship between different types of quantities with **different units**.
  - For example: A car's speed is a rate usually written in kilometres per hour (km/h).
- Rates are always written with two different units, unlike simplified ratios, which are written without units.
  - For example: rate $\$50/10\text{ m} = \$5/\text{m}$
  - For example: ratio 60 cents : \$1 $= 60:100 = 3:5$
- The word **per** is used instead of the words 'divided by' or instead of the dividing symbol '/' (also known as a solidus).

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- When simplifying rates, we find the amount of the first quantity per 1 unit of the second quantity.
  - For example: 32 km walked over 8 hours would be simplified to how many kilometres walked in 1 hour. Dividing both parts by 8 gives 4 km/h.
- It is conventional to write rates in their simplest form.
- The **average rate** is the change in the first quantity divided by the change in the second quantity.
  - For example: Jason's report increased from 500 words to 2000 words from 8 p.m. to 8:40 p.m. Average typing rate = change in words/change in time.

$$\div 40 \begin{cases} = 1500 \text{ words/40 min} \\ = 37.5 \text{ words/min} \end{cases} \div 40$$

Example 1 Identifying a rate

Determine whether or not each of the following is a rate.

a increasing 2 kg to 5 kg

b $12 per 2 kg

c 250 mL

WORKING	THINKING
a This is a ratio but not a rate.	Look for the word **per** to identify a rate.
b This is a rate.	This gives a number of dollars **per** number of kilograms.
c This is not a rate.	This is a measurement, not a rate.

Example 2 Determining suitable units for common rates

Recall the typical units for the following rates.

a the speed of a bicycle

b the cost of fish

WORKING	THINKING
a km/h	A cyclist usually travels some kilometres every hour, so typical units are km per h. Use the symbol / for per.
b $/kg	Fish are generally weighed in kg and sold for dollars, so typical units are $ per kg. Use the symbol / for per.

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Example 3 Writing a rate and simplifying it

Use division to write each of the following as simplified rates.

a $34.95 is the cost of a 5 kg piece of ham.

b Monica took 36 minutes to drive 8 laps in her go-cart.

WORKING	THINKING
a $\div 5$ ($34.95/5 kg$ / $6.99/kg$) $\div 5$	Convert the rate to $ per kg. Divide both sides by 5. Round to two decimal places for money.
b $\div 8$ ($36 min/8 laps$ / $4.5 min/lap$) $\div 8$	Convert the rate to minutes per lap. Divide both sides by 8.

Example 4 Calculating an average rate of change

Calculate the average rate of change in the following situations.

a Joseph walked 150 km in 5 days.

b When Blake was aged 9 he wore a size 5 shoe, and at age 17 he wore a size 11 shoe.

WORKING	THINKING
a $\div 5$ ($150 km/5 days = 30 km/day$) $\div 5$	The distance travelled was 150 km over 5 days. Divide distance by the 5 days to get the average km per day.
b size $11 - $ size $5 = 6$ sizes $17 - 9 = 8$ years $\div 8$ ($6 sizes/8 years = 0.75 sizes/year$) $\div 8$	The increase shoe size is $11 - 5 = 6$ sizes. Divide the size change by 8 years to calculate average size change per year.

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Example 5 Applying rates in a real-world situation

Kirra cycles 42 km in 72 minutes. Skye finishes a 30 km cycling race in 58 minutes. Calculate the rate of change of distance (i.e. speed) in km/minute, correct to one decimal place, for both cyclists. Who has the fastest rate?

WORKING	THINKING
Kirra	Write the rate from the information given. Calculate the rate per minute by dividing both sides by 72 and rounding to one decimal place.
$\div 72$ (42 km/72 min = 0.6 km/min) $\div 72$	
Skye	Write the rate from the information given. Calculate the rate per minute by dividing both parts by 30 and rounding to one decimal place.
$\div 58$ (30 km/58 min = 0.5 km/min) $\div 58$	
Kirra has the fastest rate.	Identify that Kirra's cycling rate is a larger number and write your answer as a short sentence.

Exercise 2A

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in the following statements.

- **a** Rates show the relationship between _____ types of quantities with _____ units.
- **b** Rates are always written ____ units. Simplified ratios are written _____ units.
- **c** A simplified rate gives the amount of the first quantity per _____ unit of the second quantity.
- **d** The average rate is the _____ in the first quantity divided by the _____ in the second quantity.

Example 1

2 Determine whether or not each of the following is a rate.

Hint A rate compares amounts with different units.

- **a** 80 km/hour
- **b** 5 litres/minute
- **c** increase from 120 km to 500 km
- **d** $28/kg
- **e** 25 cm^2
- **f** 1 point/minute
- **g** 30 degrees to 90 degrees
- **h** 60 000 cans/hour

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Example 2

3 Recall the typical units for the following rates.

a The speed of a 100 m sprinter
b The cost of buying grapes
c The cost of petrol
d A person's typing speed
e The calorie content in a breakfast cereal
f The speed of a car
g The cost of buying land
h A cricket team's run rate

Example 3

4 Use division to write each of the following as simplified rates. Round your answer to one decimal place if needed.

Hint A simplified rate is written per 1 unit of the second quantity.

a 300 km travelled in 5 hours
b $7 for 4 kg of apples
c $180 000 for 600 m^2 of land
d 12 tries in six games
e 660 mL of rainfall in 30 days
f 5000 revolutions of a jet engine rotor in 30 seconds
g 48 customers served at a drive-thru in 1.5 hours
h 20 000 bottles filled in 7 hours at a factory
i 250 km travelled in 4.5 hours
j 80 jumps in 60 seconds

Example 4

5 Calculate the average rate of change in the following situations. Round your answer to one decimal place if needed.

Hint An average rate is written per 1 unit of the second amount.

a John drives 1200 km in 3 days.
b Stormy the kitten gains 4 kg over 6 months.
c Tim runs 20 km in 2 hours.
d Brenda eats 12 lollies in 5 minutes.
e Sam the snail travels 1.2 metres in 3 hours.
f In her netball match Melanie scores 20 goals in 15 minutes.
g Jonah notices the temperature was 22°C at 6 a.m. and then 34°C at 2 p.m.
h Luther was 100 cm tall in 2012 and is 149 cm tall in 2019.

APPLICATIONS

SF: 6–13 | CF: – | CU: –

Example 5

6 Kane cycles 50 km in 108 minutes. Archie finishes a 42 km cycling race in 90 minutes.

a Calculate Kane's rate of change of distance (i.e. speed) in km/minute, correct to two decimal places.
b Calculate Archie's rate of change of distance (i.e. speed) in km/minute, correct to two decimal places.
c Determine who has the fastest rate of movement.

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7 Round your answers to the following to two decimal places where necessary.

a A car uses 26 litres of fuel to travel 208 km.

i Use division to express this as a simplified rate in km/litre.

ii Use division to express this as a simplified rate in litres/km.

b i Calculate 208 ÷ 100.

ii Use division to express the information as a simplified rate in litres/100 km.

8 Amanda purchases 4 kg of chips and 16 litres of soft drink for a party. She has invited 32 guests to her party, where the chips and drink will be shared equally.

a i Calculate the number of grams in 4 kg.

ii Calculate how many grams of chips each guest receives. Express this as a rate of unit grams/person.

b i Calculate the number of millilitres in 16 litres.

ii Calculate how many millilitres of soft drink each person receives. Express this as a rate with appropriate units.

★ **9** If sausages cost $8 for 20 sausages, calculate the cost per sausage.

★ **10** Jarvi was 51 cm when he was born. He grows at a rate of 8 cm/year until he is 16 years old. Determine Jarvi's height when he turns 16 years old.

★ **11** The North Queensland Cowboys had a club membership of 8000 in 2015 and now have a club membership of 17 000 in 2018. Calculate the average rate of membership growth of the club for this time period.

★ **12** Marissa finds a leaking tap and places a 6 litre bucket underneath it to catch the leaking water. The bucket fills in 4 hours. Calculate how long it will take to fill a 15 litre bucket.

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PROBLEM-SOLVING

13 Brooke's Boat Hire company charges $20 to hire a boat and then $12 per hour that the boat is used. Jessica's Jetty hires out boats at a flat rate of $16 with no initial cost.

a Calculate the cost of hiring a boat from each company for the lengths of time given in the table.

Time (in hours)	Cost of hire from Brooke's Boat Hire	Cost of hire from Jessica's Jetty
1		
2		
3		

b Determine the number of hours when each company's hiring cost is the same.

c **i** Determine which company, Brooke's Boat Hire or Jessica's Jetty, has the best offer for hiring a boat for the whole day (8 hours).

ii Calculate how much you would save when hiring a boat for a whole day from the company with the best offer.

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2B Converting units

LEARNING GOALS

- Convert between speed in km/h and speed in m/s
- Convert the units of various rates by applying unit conversion rules
- Apply conversion of units to rates in real-world situations

When is it essential to convert the units of a rate?

To compare rates, all need to have identical units. For example, there are many units of speed, such as miles/h, km/h and m/s. So to compare speeds the units must be the same.

Rate units also need changing when the given rate for the application of a product doesn't match the required amount for a particular task. People working in trades regularly convert the manufacturers' stated units of application to units that are appropriate to the job they are working on.

A tiler can convert a rate of 1 litre of water per 4 kg tile adhesive to a usable rate of 125 mL of water per 500 g tile adhesive.

WHAT YOU NEED TO KNOW

- Converting speed units
  - To convert from m/s to km/h, *multiply* by 3.6: $\text{m/s} \times 3.6 \rightarrow \text{km/h}$
  - To convert from km/h to m/s, *divide* by 3.6: $\text{km/h} \div 3.6 \rightarrow \text{m/s}$
- When converting from mph (miles per hour) to km/h, use the conversion 5 miles = 8 km.
  - 5 mph = 8 km/h

    Hence, 1 mph $= \frac{8}{5}$ km/h

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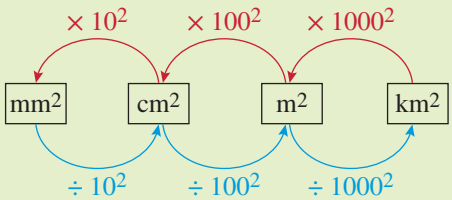
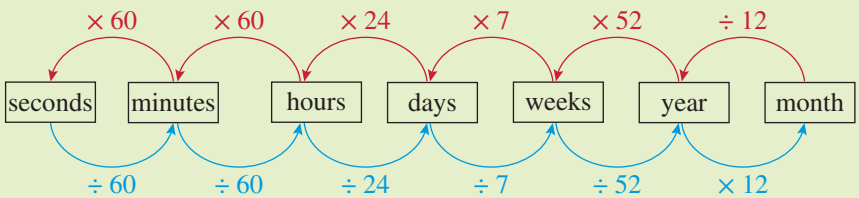
- To convert between area units, square the length unit conversion factors.



- Other area unit conversions
  - 1 hectare = 1 ha = 10 000 m^2
  - 1 ha = 2.47 acres
- Time conversion units



- Useful time unit conversions
  - $\frac{\text{number of weeks}}{52} \times 12 = \text{number of months}$
  - $\frac{\text{weekly wage} \times 52}{12} = \text{monthly wage}$
- When converting to another unit of measure, it is important to think whether your answer should be greater or smaller, to decide whether to multiply or divide by the conversion number.

Example 6 Converting between metres per second and kilometres per hour

a Convert 24 m/s to km/h, given that 1 m/s = 3.6 km/h.
b Convert 100 km/h to m/s, given that km/h ÷ 3.6 gives m/s.

WORKING	THINKING
a 24 m/s × 3.6 = 86.4 km/h	1 m/s = 3.6 km/h To convert from m/s to km/h multiply by 3.6.
b 100 km/h ÷ 3.6 = 27.78 m/s or 27.8 m/s	km/h ÷ 3.6 = m/s To convert from km/h to m/s divide by 3.6.

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Example 7 Converting units of rates by applying unit conversion rules

Convert the following rates to the units shown in the brackets.

a \$12/m (\$/cm)

b 21 700 cans/month (cans/year)

WORKING	THINKING
a \$12/m ÷ 100 = \$0.12/cm	1 cm is $\frac{1}{100}$ × smaller than 1 m, so it will cost *less* per cm, so *divide* by 100.
b 21 700 cans/month × 12 = 260 400 cans/year	1 year is 12 × larger than 1 month, so *more* cans will be produced per year than per month, so *multiply* by 12.

Example 8 Applying conversion of units to rates in real-world situations

In 2016, American athlete Kendra Harrison set a world record in the 100 m hurdles event, at a speed of approximately 8.2 m/s.

a Determine her speed in km/h.

b Kendra is faster than which of the following animals? A greyhound running at 60 km/h; a cat running at 48 km/h; a mouse moving at 14 km/h; and a snake travelling at 24 km/h.

WORKING	THINKING
8.2 m/s × 3.6 = 29.52 km/h	1 m/s = 3.6 km/h, so multiply 8.2 by 3.6.
Kendra is faster than both the mouse and the snake.	Compare with the animal speeds and write the answer in a sentence.

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Exercise 2B

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in the following statements.

a To convert from m/s to km/h, _____ by 3.6.

b _____ by 3.6 to convert from km/h to m/s.

c To convert between area units, _____ the length unit conversion factors.

d $\frac{\text{Number of } \square}{52} \times 12 = \text{Number of } \_\_\_\_\_$

e $\frac{\square \text{ wage} \times 52}{12} = \_\_\_\_\_ \text{ wage}$

Example 6

2 Convert the following speed units, rounding to one decimal place if needed.

a Convert metres/second to kilometres/hour, given that 1 m/s = 3.6 km/h.

i 20 m/s **ii** 12 m/s **iii** 4.25 m/s **iv** 67.5 m/s

b Convert kilometres/hour to metres/second, given that km/h ÷ 3.6 produces m/s.

i 60 km/h **ii** 110 km/h **iii** 80 km/h **iv** 6 km/h

At 100 km/h on a dry road, a car's stopping distance is 100 m.

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Example 7

3 Convert the following rates to the units shown in the brackets.

Hint: 1 hectare = 10 000 m^2
1 tonne = 1000 kg

a $80/litre ($/mL)
b $250/kg ($/gram)
c $1 200 000/hectare ($/m^2)
d 24 000 cans/day (cans/hour)
e 2500 mL/year (litres/year)
f 1.25 m/min (cm/min)
g 0.125 kg/year (grams/year)
h 7600 tonnes/month (kg/month)

4 Harry earns $1400/week, which is based on a 36-hour, 5-day working week. Determine the following rates of Harry's income.

Hint: Monthly wage = weekly wage × 52 ÷ 12

a $/day
b $/fortnight
c $/hour
d $/year
e $/decade
f $/month

5 Juanita earns $2060/week, which is based on a 36-hour, 5-day working week. Find her income over the following different time periods.

a $/day
b $/fortnight
c $/hour
d $/year
e $/decade
f $/month

Hint: A month is found by multiplying a week by 52 and then dividing by 12.

APPLICATIONS

SF: 6–15 | CF: – | CU: –

Example 8

6 Alyssa worked for 74 hours to paint the interior of a new house. She was paid $3515 for this job.
a Calculate her rate of pay in $/h.
b Alyssa works a 40-hour week. Determine her rate of pay in $/week.

Paint coverage rate is expressed in m^2 per litre.

7 A swimming pool has developed a slow leak and is leaking water at a rate of 10 mL per second.
a Use a suitable calculation to express this rate in litres per hour.
b The pool contains approximately 48 000 litres of water. If the leak goes unnoticed, determine how long it will take for the pool to empty.

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8 The Indianapolis 500 is a 500-mile car race held in Indiana, USA. Convert the following record speeds from mph to km/h, rounded to two decimal places.

Hint: 5 mph = 8 km/h
1 mph = $\frac{8}{5}$ km/h

a The fastest lap speed ever is 239.26 mph, recorded during a practise session.

b The fastest lap speed recorded during a race is 236.103 mph.

★ 9 The scale on a map is 5 cm to 100 km. Determine the scale of the map in mm per km.

★ 10 After heavy rain, 15 000 litres of water flows into a dam in 2.5 hours. Calculate the rate at which water flows into the dam in:

a litres/hour **b** litres/minute

★ 11 Julia rides 8 km on her bike in 45 minutes. Calculate Julia's average speed in km/h.

★ 12 It is estimated that your ears continue to grow at a rate of 0.22 mm per year as you age, as a result of gravity. If George has ears that are 7.2 cm long at the age of 50, how long will his ears be, in cm, when he is 80 years old?

★ 13 The average sloth moves at a speed of 240 m/h. Convert this rate to km/h and then determine after how many hours the sloth travels 0.6 km.

★ 14 Chris decides to grow her hair long and wants it to be 60 cm longer to cover her entire back. Hair grows at about 0.15 m per year. Convert this rate to cm/year and, hence, determine how long Chris will need to grow her hair to cover her back.

★ 15 A cheetah runs at approximately 30.5 m/s. Convert this to km/h and determine the road speed limit that would be best suited for a car travelling at the same speed. The various speed limits are: 40 km/h, 50 km/h, 60 km/h, 80 km/h, 100 km/h and 110 km/h.

PROBLEM-SOLVING

16 Some of the slowest-moving creatures on Earth are the sloth, snail, tortoise and worm. Use suitable calculations to determine which of the creatures is the slowest.
The average speeds are: snail 0.013 m/s, worm 0.2 cm/s, tortoise 0.48 km/h and sloth 240 m/h.

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2C Solving problems using rates and direct proportion COMPLEX

LEARNING GOALS

- Find an unknown value, using rates and direct proportion
- Change rates using direct proportion
- Solve problems involving direct proportion in real-world contexts

Who finds it essential to use direct proportion in their work?

Every person who uses a product for a smaller or larger application than the rate stated by the product's manufacturer finds it essential to use direct proportion. Countless people regularly use direct proportion, including chemists, farmers, cooks, nurses, doctors, mechanics, construction workers, plumbers, electricians, currency converters, engineers, hairdressers and DIY people.

For example, a home gardener who needs to mix fertiliser for a 100 m^2 garden uses direct proportion to convert the manufacturer's rate appropriate for farms of 70 kg/hectare (i.e. 70 kg/10 000 m^2) to calculate a home garden rate of 700 g/100 m^2.

Landscapers use direct proportion to adjust fertiliser application rates, to calculate quantities suitable for home gardens and lawns.

WHAT YOU NEED TO KNOW

- Two quantities in **direct proportion** increase together or decrease together at a constant rate.
  - For example: Ellie's wages are in direct proportion to the hours she works. Ellie's wages increase at a rate of $20/h as her hours of work increase.

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- All parts of a rate must be multiplied or divided by the same factor to maintain equivalence.
  - For example: If chlorine is added to a swimming pool at a rate of 40 g/10000 L, then for a pool with five times the volume (i.e. 50000 L) the amount of chlorine required is 5×40 g $= 200$ g.
- An unknown value is represented by a variable such as x or y. These variables indicate a value that is to be calculated.

Example 9 Finding an unknown value using rates and direct proportion

Money, in $, is in direct proportion to time, in hours. Calculate the value of x if $24 in 1 hour is equivalent to $x in 6 hours.

WORKING	THINKING
$\times 6$ (\$24/1 hour = \$144 km/6 hours) $\times 6$ $x = \$144$	As the number of hours is multiplied by 6, also multiply the dollars by 6.

Example 10 Changing rates using direct proportion

The Hart family consume six bottles of juice in three days. Determine how many bottles they would consume in:

a one day

b eight days

WORKING	THINKING
a $\div 3$ (6 bottles/3 days = 2 bottles/1 day) $\div 3$ The Hart family would consume two bottles in one day.	Three days divided by 3 gives one day, so divide the six bottles by 3 to get two bottles.
b $\times 8$ (2 bottles/1 day = 16 bottles/8 days) $\times 8$ The Harts would consume 16 bottles in eight days.	One day multiplied by 8 gives eight days, so multiply the two bottles by 8 to get 16 bottles.

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Example 11 Solving a direct proportion problem in a real-world context

A Holden Commodore V8 police car has a fuel consumption rate of 12.6 litres per 100 km. If the car starts with a full 80 litre fuel tank, determine how far it could travel before its fuel tank is empty.

WORKING	THINKING
÷ 12.6 ↘ 12.6 litres/100 km ↘ ÷ 12.6 1 litre/7.94 km × 80 ↘ 80 litres/635 km ↘ × 80 The car should be able to travel 635 km.	Write the fuel consumption rate in litres/100 km. Fuel used is in direct proportion to the distance travelled. So divide both parts of the rate by 12.6 to find the distance per 1 litre of fuel. Multiply both parts of the rate by 80, to find the distance travelled with 80 litres of fuel.

Exercise 2C

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in the following statements.

a Two quantities in _____ proportion increase together or _____ together at a _____ rate.

b To calculate an _____ rate, both parts of the rate must be multiplied or _____ by the _____ factor.

Example 9

2 In each of the following, calculate the value of x if:

a 80 km travelled in 1 hour is equivalent to x km travelled in 4 hours

b \$12.75 earned in 1 hour is equivalent to \$$x$ earned in 6 hours

Hint First write the rate, then apply the same operation to both parts of the rate.

c 9 litres used in 1 minute is equivalent to x litres used in 4.5 minutes

d two questions completed in 1 minute is equivalent to x questions completed in 1 hour

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e 210 km travelled in 3 hours is equivalent to x km travelled in 9 hours

f \$90 earned in 4 hours is equivalent to earning \$$x$ in 1 hour

g 120 litres leaked in 6 hours is equivalent to 40 litres leaked in x hours

h 30 hours in 21 days is equivalent to 10 hours in x days

Example 10

3 Find the value of x and y in the following.

a 10 500 cans produced in 7 days
= x cans produced in 1 day
= y cans produced in 10 days

b it costs \$56 for 4 litres
= \$$x$ for 1 litre
= \$$y$ for 11 litres

c 200 metres travelled in 8 minutes
= x m travelled in 1 minute
= y m travelled in 30 minutes

d \$45 earned for working 3 hours
= \$$x$ earned for working 1 hour
= \$$y$ earned for working 5 hours

e 350 km travelled in 5 hours
= x km travelled in 1 hour
= y km travelled in 8 hours

f 108 texts sent in 6 hours
= x texts sent in 1 hour
= y texts sent in 13 hours

APPLICATIONS

SF: – | CF: 4–17 | CU: –

Milking machines increase the rate of milk flow per hour.

4 At milking time, a dairy produces 22 litres/minute.

a Determine how many litres of milk are produced in 60 minutes.

b Determine how many litres are produced in 2 hours of milking.

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5 In a fruit and vegetable shop, 4 kg of tomatoes cost $4.80.
- **a** Determine the cost per kilogram.
- **b** Calculate the cost of purchasing 2.5 kg of tomatoes.

6 Nectarines are sold for $3 per kilogram when they are in season.
- **a** Determine the cost of:
  - **i** 2 kg of nectarines
  - **ii** 4.5 kg of nectarines
- **b** Calculate how many kilograms of nectarines can be purchased for $10.50.

7 A restaurant uses 750 litres of olive oil in a 30-day period.
- **a** Calculate the rate at which olive oil is used, in litres/day.
- **b** Determine how many litres of olive oil the restaurant would expect to use in one year.
- **c** The restaurant purchases good quality olive oil for $10.40 per litre. Calculate how much it would spend on olive oil in one year.

Example 11

★ 8 The new BMW turbo diesel police cars claim a fuel consumption of 5.1 L/100 km. If a car starts with a full 70 litre fuel tank, determine how far it could travel before its fuel tank is empty.

★ 9 The Morello family's water bill states that they use an average of 550 litres per day of water. Calculate the number of litres of water they would use in one year.

★ 10 If four ice-creams cost $18, calculate the cost of five ice-creams.

★ 11 Calculate the cost of paving a driveway that is 5 m wide and 8 m long if paving costs $75 per square metre.

★ 12 A team of bricklayers can lay the 12 000 bricks used to build one house, in four days. After 38 days' work at this rate, calculate how many houses this team has built.

★ 13 A group of four friends goes camping and needs to buy $210 worth of food for the trip. If five more people decide to join them, determine the cost of food for the entire group.

Bricklayers can be paid at a rate of $1.80/brick and work at a rate of 400 bricks/day.

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★ **14** At a school camp two teachers are legally required to supervise a maximum of 13 students swimming in the river. If three teachers are available, determine how many students are able to go swimming at a time.

Hint Round down when the maximum value is a decimal answer.

★ **15** The Nguyen family leave home for their family holiday. They leave home at 6 a.m. They plan to have morning tea at a town that is 275 km away from home. If they travel at an average speed of 85 km/h, calculate at what time they would expect to stop for morning tea.

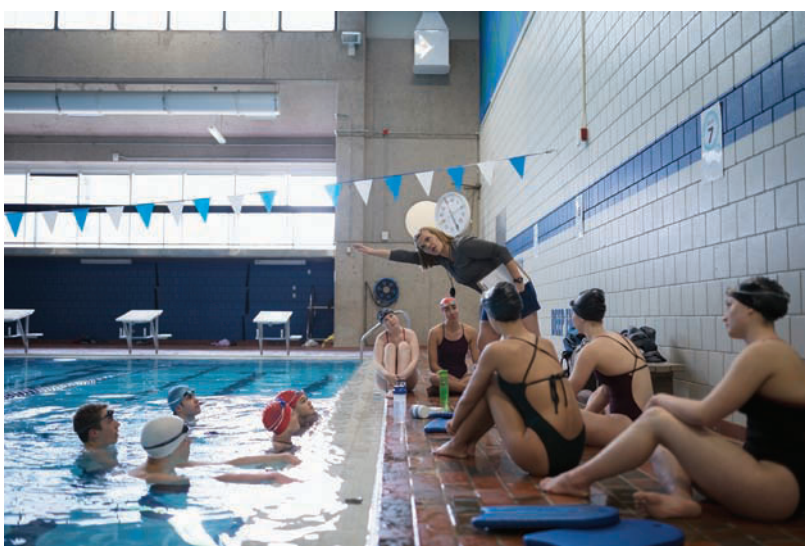
★ **16** When travelling on a highway, a hybrid car has a fuel consumption of 4.1 litres per 100 kilometres. If this car travels at an average speed of 95 km/h for 2 hours, how much fuel will it consume?

★ **17** A modern Porsche drives 16.4 km on 1 litre of fuel. Calculate how many litres would be needed for this Porsche to drive from Brisbane to Cairns, which is a distance of 1640 km.

PROBLEM-SOLVING

18 The supervision rates of school students for swimming are three teachers per 21 primary school students and two teachers per 30 high school students.

If 174 students are swimming and 18 teachers are required, determine the ratio of primary students to secondary students.



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2D Comparisons using rates and determining best value

LEARNING GOALS

- Compare rates of price per equal weight or volume to find the best value buy:
  - with a calculator; and
  - without a calculator.
- Solve best value rate problems in real-world situations

When would it be essential to compare rates?

Examples of when rates are compared include determining the best value for money, the most efficient production rates and the most economical rates of energy usage. Also, we can compare our pay rates to the Australian award pay rates, and we all need to compare our car's speed to the speed limit.

Milk is one of the many items sold in various-sized containers. Comparing costs of equal volumes or weights will identify the best buy for a product.

When a company makes decisions about large investments, it will consider and compare many types of rates. For example, a new building with a higher cost rate in $\$/m^2$ may be compared with alternative buidlings that have lower cost rates. The company may consider whether the higher cost building will be longer lasting than one with a lower cost rate, which would require more frequent maintenance.

WHAT YOU NEED TO KNOW

- To find the **best buy**, convert each price option to the cost of equal amounts.
  - For example: The option on the left is the best buy of these two brands of chainsaw oil.

$$\div 3 \left(\begin{array}{l}\$76.50/6\text{ L} \\ = \$25.50/2\text{ L}\end{array}\right) \div 3 \qquad \div 4 \left(\begin{array}{l}\$106/8\text{ L} \\ = \$26.50/2\text{ L}\end{array}\right) \div 4$$

- The best value can be either the lowest rate or the highest rate, depending on the situation.

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- For example: The lowest rate is the best value for a car's fuel economy in litres/100 km.
- The highest rate of data download, in Mbps (megabits per second), is the best value.

Example 12 Comparing rates to find the best value buy, without a calculator

Without a calculator, determine the cost of the following sugar brands per 100 grams and, hence, determine the best buy.

500 grams of Soft Sugar costs $2.25 and 300 grams of Sun Sugar costs $1.50.

WORKING	THINKING
Soft Sugar $2.25 ÷ 5 = $0.45/100 grams	Since 500 grams is 5 × 100 grams, divide $2.25 by 5.
Sun Sugar $1.50 ÷ 3 = $0.50/100 grams	Since 300 grams is 3 × 100 grams, divide $1.50 by 3.
It is the best value to buy the 500 g packet of Soft Sugar.	The lowest cost per 100 g is the better buy. Write the answer as a sentence.

Example 13 Comparing rates to determine the best value buy, using a calculator

Determine the best value (i.e. the cheaper deal) between these products: 1.5 litres of Frank's Lemonade for $1.80 and 2.5 litres of Lucy's Lemonade for $2.80.

WORKING	THINKING
Frank's Lemonade ÷ 1.5 ($1.80/1.5 litres = $1.20/L) ÷ 1.5	Write the information as the rate $/litre. 1.5 L ÷ 1.5 = 1 L, so we also divide $1.80 by 1.5.
Lucy's Lemonade ÷ 2.5 ($2.80/2.5 litres = $1.12/L) ÷ 2.5	2.5 L ÷ 2.5 = 1 L, so we also divide $2.80 by 2.5.
2.5 L of Lucy's Lemonade is the best buy.	The lowest cost per litre is the best value.

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Example 14 Solving best value rate problems in real-world situations

A carton of 20 cans of lemon soft drink costs $10.95 and a carton of 36 cans of lemon soft drink costs $20.95. Which is the cheapest way to buy the lemon soft drink?

WORKING		THINKING
$10.95/20 cans	$20.95/36 cans	Write as the rate $ per can.
$10.95 ÷ 20	$20/36	Divide $10.95 by 20 to find the cost per can.
= $0.55/can	= $0.58/can	Divide $20.95 by 36 to find the cost per can.
The best value is to buy the carton of 20 cans.		The lowest cost per can is the best value.

Exercise 2D

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in the following statements.

- **a** To find the _____ buy, convert each price option to the cost of _____ amounts.
- **b** The best value can be either the _____ rate or the _____ rate, depending on the situation.
- **c** The _____ rate is _____ value for a car's fuel economy, in litres/100 km.
- **d** The _____ rate of data download, in Mbps, is the _____ value.

Example 12

2 Without a calculator, determine the cost of the following items per 100 grams and, hence, determine the best buy.

Hint First write each as a rate per 100 g.

- **a** 500 grams of washing detergent for $2.25 and 1.2 kg of washing detergent for $5.04.
- **b** 300 grams of dim sims costs $1.95 and 1 kg of dim sims costs $6.10.
- **c** 750 grams of flour costs $1.65 and 500 grams of flour costs $1.05.
- **d** 250 grams of cereal costs $3.20 and 600 grams of cereal costs $7.74.

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Example 13

3 Determine the best value (i.e. the cheaper deal) between each of the following.

Hint First write each rate per equal quantity of the second amount.

- **a** 2.4 litres of cordial for $3 or 1.75 litres of cordial for $2.10?
- **b** 250 grams of coffee for $5.70 or 400 grams of coffee for $10.20?
- **c** 1.5 kg of oranges for $4.80 or 2.5 kg of oranges for $8.25?
- **d** Phone internet plan A is 3 GB for $22 or plan B is 5 GB for $36?

APPLICATIONS

SF: 4–12 | CF: – | CU: –

4 At the supermarket, dishwasher soap tablets can be purchased in a box of 40 for $14 or a box of 320 for $79.

- **a** Calculate the cost per tablet for each box.
- **b** Determine how much cheaper it is per tablet for the best buy.

Calculating the best buy can result in big savings over a year.

5 A bottle of milk can be bought in several different sizes at different prices. At a local supermarket, a 600 mL bottle costs $1.20 and a 2 litre bottle costs $3.60.

- **a** Determine the cheapest way to buy the milk.
- **b** Explain why the cheapest option may not be the most suitable in some circumstances.

Example 14

★ 6 A carton of 24 cans of Super soft drink costs $12.99 and a carton of 30 cans of Cool soft drink costs $16.99. Compare these prices and determine the cheapest way to purchase cans of soft drink.

Hint Write each price in $ per can.

★ 7 A service station sells 600 mL bottles of soft drink for $3.20 and 1 litre bottles of soft drink for $5.50. Use a suitable calculation to determine the cheapest way to buy the soft drink.

★ 8 Loose grapes can be purchased at a price of $4 per kilogram. The same type of grapes also can be purchased in a prepacked container for $3 per 600 grams. Calculate how much more expensive it is per kilogram to buy the prepacked grapes.

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★ **9** Ibrahim and Yohann are fit bushwalkers who like to compare their long-distance walking speeds to see who is the faster. Ibrahim walks 60 km in 8 hours and Yohann walks 55 km in 7 hours. Which bushwalker has the faster walking rate?

★ **10** A store is selling bulk potato chips at $5.49 for a 600 gram packet. If a 175 gram packet of the same type of chips costs $1.59, determine the cheapest way to buy the chips.

★ **11** Hayden's car uses 40 litres of fuel to travel 520 km and Aria's car uses 50 litres of fuel to travel 645 km.

a Determine whose car is the most economical.

b If fuel costs $1.49/litre, calculate how much it will cost in fuel for each car owner to travel 904 km from Townsville to Mt Isa.

★ **12** Bethany's car uses 65 litres of fuel to travel 780 km and Teri's car uses 55 litres of fuel to travel 638 km.

a Determine whose car is the most economical.

b If fuel costs $1.57/litre, calculate how much it will cost in fuel to travel 1726 km from Port Douglas to Toowoomba.

Fuel efficiency in L/100 km is a useful rate calculation.

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PROBLEM-SOLVING

13 Sheldon is arranging a party for 18 people, and will be catering for some treats and beverage per person. Sheldon determines that each person will drink 600 mL of soft drink, eat two party pies, four tiny sausages and 100 grams of corn chips.

Soft drink costs $1.80 for 1.25 litres or $2.80 for 2 litres.
Party pies cost $3.42 for 18 pies or $4.80 for 24 pies.
It costs $4.20 for 24 little sausages or $5.40 for 30 little sausages.
Corn chips cost $5.49 for 600 grams or $2.39 for 250 grams.

Using the prices given, calculate the following. Remember that the best value might not be the cheapest way to purchase items if the quantity doesn't match how much is required.

a the quantity of each item to buy
b the best buys for each item
c the cheapest cost for supplying these items for Sheldon's party

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Problem-solving and modelling task

PLANNING A ROAD TRIP

Background: Planning a trip requires comparison of many different cost rates, and rates based on time such as speed.

Task: Your task is to plan a return trip for two people to a destination that is more than 8 hours' drive away from your home town. Then you are to compare the costs of driving with either flying or travelling by bus to your chosen destination.

You will use rates to determine the costs and time required to make your round trip. For example, if driving from Bundaberg to Bowen, you might average 80 km/h (i.e. when considering breaks).

For determining the cost of flying, research either airline sites or popular sites such as webjet.com.au.

You will then compare both costs and travel times, and draw a conclusion for the best value mode of travelling for two people between your two chosen towns.

To complete this task, follow the problem-solving workflow diagram on the following page and use the steps listed as a guide.

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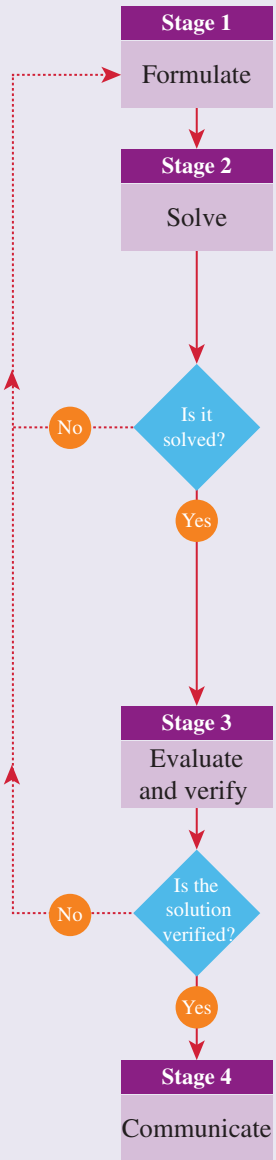

Stage 1: Formulate

1. Decide on the car that you will drive.
2. Investigate possible journeys you might take.

Stage 2: Solve

3. Determine its fuel economy by referring to a website such as carsales.com.
4. Search Google to determine the distance between your two towns.
5. Determine the current cost of fuel, in $ per litre.
6. Calculate the fuel required, in litres.
7. Calculate the cost of fuel needed for the car trip.
8. Calculate the total time needed (including all breaks and stop-overs) to drive the return journey.
9. Use a suitable website to find the costs and travel times to fly or to travel by bus for a return journey between these two places.

Stage 3: Evaluate and verify

10. Compare the total costs of the trip when driving with flying or travelling by bus.
11. Compare the travel times of driving with flying or bussing between your town and chosen destination.

Stage 4: Communicate

12. Communicate your findings in a short report of whether you decide to drive or fly or travel by bus to complete your journey. In your report refer to the different costs and time calculations that you have made.

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Puzzle

The first cash register was invented in 1879 in America. It was a purely mechanical adding machine with its design based on a tool that counted the number of revolutions of a certain 'item'.

You will discover this item when you solve the following questions and use the answers to fill in the question letter above the answer in the grids below.

Use division to write each of the following as simplified rates (rounded to two decimal places if needed).

A \$9 per 4 kg

E 280 jumps in 15 minutes

Convert the following rates to the units shown in the brackets.

H 250 cm/hour (m/hour)

I three cans per minute (cans/hour)

Calculate the following speeds in km/h, given that 1 m/s = 3.6 km/h.

L 35 m/s

M 7.25 m/s

Determine the value of x in each of the following.

O \$4.50 for 1 kg is equivalent to \$$x$ for 7 kg

P \$52 for 2 kg is equivalent to \$$x$ for 5 kg

R If Joey can wrap three presents in 20 minutes, determine how many presents he can wrap in 3 hours.

S Determine which is the best value: a 180 gram packet of chips that costs \$2.25 or a 150 gram packet of chips that costs \$1.75?

T For each of the following vehicles, calculate the fuel economy, in km/litre, and then determine which is the most economical: the Mercury, which travels 600 km with 48 L, or the Jupiter, which travels 520 km with 40 L.

2.25	150	12.5	18	2.25	26.1	150	2.5	180	130

130	27	31.5	130	18	126	126	18	27

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Chapter checklist

☐ I understand the fundamentals of rates.

1 Identify which of the following are examples of rates: 16 m/s, 12 cm^2, 12 cans per second, \$6/kg, \$4 to 80 cents.
2 Recall the typical unit that would be used to describe the speed of an aeroplane.

☐ I can simplify rates and calculate average rates.

3 Write as a rate and use division to simplify: 21 goals in three games.
4 Calculate the average growth rate of a dog that has grown 12 cm between January 2017 and January 2020.

☐ I can convert the units of rates.

5 Convert 1750 m/h to km/h.
6 Convert 47 m/s to km/h.
7 Convert 90 km/h to m/s.

☐ I can determine the value of an unknown, using direct proportion. [Complex]

8 125 litres used in 15 hours = 25 litres used in x hours. Find x.
9 \$14 for 2 kg = \$$x$ for 9 kg. Find x.
10 Linda can swim 200 m in 12 minutes. Calculate how long it will take her to swim 700 m at the same rate.

☐ I can find the best value by comparing rates.

11 Calculate the cost per 100 grams to determine the best value between 150 grams of tea for \$1.38 and 250 grams of tea for \$2.20.
12 Determine the best value if pine timber costs \$24 for 4.8 m and cypress timber costs \$15.60 for 3 m.
13 Fuelo station sells 60 litres of petrol for \$85.80 and Peteral station sells 70 litres of petrol for \$101.50. Determine which service station has the cheapest petrol.

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Chapter review

All questions in the Chapter Review are assessment-style.

Simple Familiar

Section 2A

1 A tray of mangoes costs $30 and each tray has 12 mangoes. Calculate the cost per mango.

2 If a car uses 32 litres to travel 420 km, calculate its fuel economy, in L/100 km.

3 Calculate the average rate of change in the following situations. Round your answer to one decimal place if needed.

a 750 mL of fluid is used up in 14 minutes

b 6 kg of flour is used in 18 days

c 160 m^3 of vegetation is cut in 2 hours (Show the average rate per minute.)

Section 2B

4 Leonard is a professional tiler and can lay 4 m^2 in 20 minutes.

a Write this as a rate of m^2/min.

b Use a suitable calculation to convert the rate to the rate of m^2/hour.

c Determine how long it would take Leonard to lay 126 m^2 of tiles.

5 The local fruit shop sells eggs at $4.20 for a dozen and $9 for a tray of 30. Determine which is the cheapest way to buy eggs.

6 A 175 gram packet of biscuits costs $2.50 and a 125 gram packet of the same brand costs $1.80. Determine which packet is the best value. Explain your answer.

7 A family uses 9.8 units of electricity a day. Calculate how much they will use in a 90-day billing period.

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Section 2D

8 Lynn's car uses 38 litres of fuel to travel 480 km and Mike's car uses 52 litres of fuel to travel 745 km.
- **a** Determine whose car is the most economical.
- **b** If fuel costs $1.49/litre, calculate how much it will cost in fuel for Lynn to travel 400 km from Roma to Emerald.

9 At the supermarket, a brand of biscuit can be purchased in a box of 20 for $3.60 or a box of 36 for $5.75. Determine whether the box with 20 biscuits or the box with 36 biscuits is the best buy.

10 Adam paints 24 m^2 in 8 hours and Bob paints 180 m^2 in 5 hours and 30 minutes. Which painter is faster, and by how much?

Complex Application

Section 2C

11 You and two friends hire a boat for $12 per hour and agree to share the cost. Just before you leave, two more friends join you and agree to share the cost. How much do you save when the two extra friends join you?

12 A patio measuring 7 m long and 4 m wide is to be paved. If paving costs $62 per m^2, how much will it cost to pave the patio?

13 The birth rate in 2017 was 12.08 babies per 1000 people. If the current population is 24 000 000, how many babies were born this year?

14 A people mover car has a fuel economy of 8.1 litres per 100 km.
- **a** Calculate how many litres of fuel is required to travel 1280 km.
- **b** If fuel costs $1.57 per litre, calculate how much it costs in fuel to travel that distance.

15 If a group of painters can paint 480 m^2 in 10 hours, determine how many hours it will take to paint 1380 m^2.

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3 Percentages

Maths for a Rugby Participation Manager: Haydn Hirsimaki

Haydn Hirsimaki has been a Rugby Participation Manager on the Sunshine Coast and Brisbane for 8 years. He was always passionate about the sport and knew that his career had to involve rugby in some form. He now gets to inspire others with his enthusiasm and love for the sport.

Tell us a bit about your job. What does a typical day look like?

As a rugby participation manager I am responsible for creating and implementing programs that increase player recruitment and retention, as well as programs that improve player and coach quality. Additionally, I have facility management duties that focus mainly around game day operations. I love my job because every day is different; one day I could be out talking to students about playing rugby, the next I could be running selection trials or coach education seminars.

What maths did you study at school?

When I was in school I studied Maths B and it provided me with some of the skills I need to perform my job.

How do you use maths in your job? Could you give some examples?

I use maths in many parts of my career. A major task of mine that requires maths is gathering game data, converting the data into relevant percentages and then providing those statistics to the coaches and players as a form of feedback on areas that need improvement. This is the type of real-world maths that is now taught in Essential Mathematics, which I believe is crucial in many sporting positions.

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In this chapter

3A Understanding percentages

3B Determining an amount as a percentage of another amount

3C Applying percentage increases and decreases, including mark-ups and discounts **[complex]**

3D Determining overall change in a quantity from multiple percentage changes **[complex]**

3E Calculating simple interest for different rates and time periods **[complex]**

Problem-solving and modelling task

Puzzle

Chapter Checklist

Chapter Review

Syllabus reference

Unit 1 Topic 2 Percentages (7 hours)

In this subtopic, students will:

- calculate a percentage of a given amount
- determine one amount expressed as a percentage of another for the same units
- determine one amount expressed as a percentage of another for different units **[complex]**
- apply percentage increases and decreases in situations, including mark-ups, discounts and GST **[complex]**
- determine the overall change in a quantity following repeated percentage changes **[complex]**
- calculate simple interest for different rates and time periods **[complex].**

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Pre-test

1 Change the following statements to the simplest improper fraction.

a one-half
b one-quarter
c one-tenth
d one-hundredth
e two-thirds
f three-hundredths

2 Change the following decimals to the simplest improper fractions.

a 0.20
b 0.60
c 0.99
d 0.64
e 1.50
f 4.75

3 Determine the final value of $1000 when it is increased by:

a $546
b $1122
c –$754

4 Determine if the following statements are true or false.

a $0.1 = \frac{1}{10}$

b $\frac{1}{3} = 0.33333\ldots$

c $0.55 = \frac{11}{55}$

5 Convert the following time frames to weeks.

a a fortnight
b one year
c two days

A link to a HOTmaths lesson is provided in the Interactive Textbook to revise this topic.

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3A Understanding percentages

LEARNING GOALS

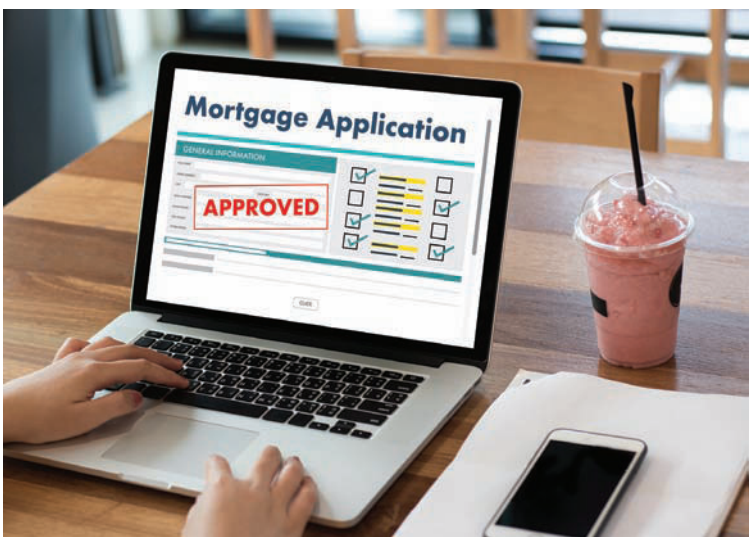
- Convert percentages to fractions
- Convert simple percentages to equivalent divisions and multiplications with whole numbers
- Calculate the percentage of a quantity with and without using a calculator
- Apply percentage calculations to real-world situations

Why are percentage calculations essential?

We can more usefully compare parts of a whole that are written as percentages than those that are written as fractions with different denominators. This is because percentages are fractions all with a denominator of 100; for example, $\frac{25}{100} = 25\%$.

A test result of $\frac{37}{46}$ is a more easily compared to a result of $\frac{19}{24}$ when they are expressed as their percentages, which are 80% in both cases.

Our whole economy is built on the exchange of money. Many money calculations use rates that are universally written as percentages. Examples include retail mark-up rates and discount rates, inflation rates, wage increase rates, tax rates, and bank interest rates for investments and loans, including mortgage rates for house loans.



A 4% per annum (p.a.) mortgage rate on a $500 000 home loan initially costs around $20 000 p.a. in interest plus the loan repayments.

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WHAT YOU NEED TO KNOW

- The word **per cent** means **per 100**. The symbol % also means **per 100**.
  - For example: 75 per cent $= 75\% = 75$ parts out of 100 parts
- A percentage is converted to a fraction when the word per cent or the symbol % is changed to a denominator of 100.
  - For example: $45 \text{ per cent} = \frac{45}{100}$ $\qquad 45\% = \frac{45}{100}$
- Common percentages and their equivalent fractions are shown in the table. It is useful to memorise these.

Percentage	1%	5%	10%	$12\frac{1}{2}\%$	20%	25%	$33\frac{1}{3}\%$	50%	$66\frac{2}{3}\%$	75%
Equivalent fraction	$\frac{1}{100}$	$\frac{1}{20}$	$\frac{1}{10}$	$\frac{1}{8}$	$\frac{1}{5}$	$\frac{1}{4}$	$\frac{1}{3}$	$\frac{1}{2}$	$\frac{2}{3}$	$\frac{3}{4}$

- Many percentages, when written as fractions, simplify to whole number divisions and multiplications.
  - For example: $5\% = \frac{5}{100} = \frac{1}{20} = 1 \div 20$. Finding 5% is equivalent to $\div 20$.
  - For example: $90\% = \frac{90}{100} = \frac{9}{10} = \div 10 \times 9$. Finding 90% is equivalent to $\div 10 \times 9$.
- A percentage of a quantity can be calculated without a calculator by first simplifying the percentage fraction and then calculating that fraction of the given quantity.
  - For example: $75\% \text{ of } 80 \text{ marks} = \frac{75}{100} \times 80 = \frac{3}{\cancel{4}_1} \times \cancel{80}^{20} = 60 \text{ marks}$
- Many percentages of a quantity can be calculated mentally using equivalent division and multiplication of whole numbers. It is easier to complete the division before the multiplication.
  - For example: $75\% \text{ of } 120 \text{ kg} = 120 \div 4 \times 3 = 90 \text{ kg}$
  - For example: $90\% \text{ of } \$210 = 210 \div 10 \times 9 = \$189$
- A calculator can be used to calculate a percentage of a quantity.
  - For example: 87.5% of 238 cm. Enter: $\boxed{87.5 \div 100 \times 238}$. Answer is 208.25 cm.

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Example 1 Converting percentages to fractions

Convert the following percentages to fractions and then use division to write each fraction in its simplest form.

a 30% **b** 76%

WORKING	THINKING
a $30\% = \frac{\cancel{30}^{3}}{\cancel{100}^{10}}$ $= \frac{3}{10}$	The % symbol is changed to a denominator of 100. Divide the numerator and denominator by the highest common factor (HCF) of 10.
b $76\% = \frac{\cancel{76}^{19}}{\cancel{100}^{25}}$ $= \frac{19}{25}$	The % symbol is changed to a denominator of 100. Divide the numerator and denominator by the HCF of 4.

Example 2 Converting simple percentages to equivalent divisions and multiplications, using whole numbers

In each of the following, write a sentence to describe how simple division, and multiplication if necessary, can be used to calculate the given percentage of a quantity.

a 10% **b** 25% **c** 80% **d** 150%

WORKING	THINKING
a To find 10% of a quantity, we divide the quantity by 10.	$10\% = \frac{10}{100} = \frac{1}{10}$ To calculate 10% of a quantity, we multiply by 1 and divide by 10, which is equivalent to simply dividing by 10.
b To find 25% of a quantity, we divide the quantity by 4.	$25\% = \frac{25}{100} = \frac{1}{4}$ To calculate 25% of a quantity, we divide by 4.

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WORKING	THINKING
c To find 80% of a quantity, we divide the quantity by 5 and then multiply by 4.	$80\% = \frac{80}{100} = \frac{4}{5}$ To calculate 80% of a quantity, we multiply by 4 and then divide by 5 (i.e. 4 lots of 20%). Tip: It is easier to divide first and then multiply.
d To find 150% of a quantity, divide by 2 then multiply by 3.	$150\% = \frac{150}{100} = \frac{3}{2}$ So to calculate 150% of a quantity, we multiply by 3 and divide by 2.

Example 3 Calculating a percentage of a quantity, without using a calculator

In each the following, use simple division, and multiplication if necessary, to calculate the percentages of the given amounts, without using your calculator.

a 10% of $140
b 25% of $600
c 125% of 500 kg

WORKING	THINKING
a $\$140 \div 10 = \$14$	10% simplifies to $\frac{1}{10}$, so we divide $140 by 10.
b $\$600 \div 4 = \$150$	25% simplifies to $\frac{1}{4}$, so we divide $600 by 4.
c $500\text{kg} \div 4 \times 5 = 625\text{ kg}$	$125\% = 5 \times 25\%$, so we divide 500 kg by 4 and then multiply by 5.

Example 4 Calculating a percentage of a quantity, using a calculator

Calculate the given percentage of each quantity, using your calculator. Round each answer to two decimal places.

a 35% of $1050
b 72% of 86.9 kg

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WORKING	THINKING
a $\frac{35}{100} \times 1050 = \$367.50$	Enter this into your calculator: $35 \div 100 \times 1050$
b $\frac{72}{100} \times 86.9 = 62.57 \text{ kg}$	Enter this into your calculator: $72 \div 100 \times 86.9$ As the third decimal place of 62.568 is 8, which is ≥ 5, round the second decimal place up to 7.

Example 5 Applying percentage calculations in real-world situations

Naomi's secret to her cake recipe is that 5% of the baked cake is sugar. If the cake weighs 300 grams when cooked, calculate the weight of sugar that Naomi uses in her cake.

WORKING	THINKING
5% of 300 g $= \frac{5}{\cancel{100}_{1}} \times \cancel{300}^{3}$ $= 15$ g	Identify that the sugar is 5% of 300 grams. Calculate 5% of 300 grams.
Naomi uses 15 grams of sugar.	Answer the question in words.

Exercise 3A

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in the following statements,

- **a** The word per cent means per _____, and the symbol % also means per ____.
- **b** When the word _____ or the symbol ___ is changed to a denominator of ____, the percentage is converted to a _____.
- **c** A percentage of a quantity can be calculated mentally by first _____ the percentage fraction and then calculating that _____ of the given quantity.
- **d** Many percentages of a quantity can also be calculated mentally using equivalent _____ and _____ of whole numbers.

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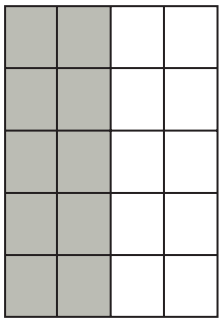
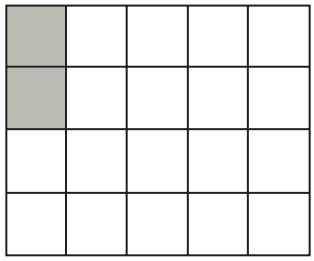
2 In each of the following, determine the percentage of the total area that is shaded.

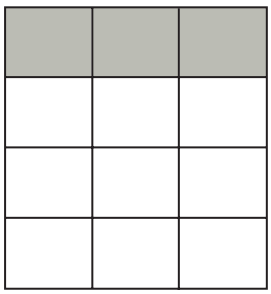
a



b

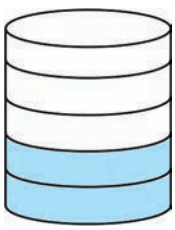


c

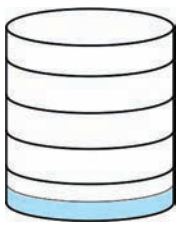


3 In each of the following, determine the percentage of the cylinder that is shaded blue.

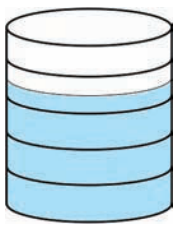
a



b



c



4 A child's drawing of a tiger is shown. Estimate the percentage of the total area of the picture that is shaded green.

5 Sketch a circle that has 75% shaded blue.

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Example 1

6 Convert the following percentages to fractions and then divide by the highest common factor (HCF), to write each fraction in its simplest form.

a 10%
b 20%
c 25%
d 40%
e 50%
f 75%
g 100%
h 15%
i 60%
j 24%
k 95%
l 88%

Hint
Divide the numerator and denominator by the HCF.

Example 2

7 In each of the following, write the percentage as a simplified fraction and use this to complete the sentence to describe how simple division, and multiplication if necessary, can be used to calculate the given percentage of a quantity.

Hint It is useful to memorise these equivalent percentage calculations.

a To find 1% of a quantity, we divide the quantity by _____.
b To find 10% of a quantity, we divide the quantity by _____.
c To find 50% of a quantity, we divide the quantity by _____.
d To find 25% of a quantity, we divide the quantity by _____.
e To find 100% of a quantity, we divide the quantity by _____.
f To find $33\frac{1}{3}$% of a quantity, we divide the quantity by _____.
g To find 20% of a quantity, we divide the quantity by _____.
h To find 80% of a quantity, we divide the quantity by _____ and multiply by _____.
i To find $66\frac{2}{3}$% of a quantity, we divide the quantity by _____ and multiply by _____.
j To find 75% of a quantity, we divide the quantity by _____ and multiply by _____.
k To find 150% of a quantity, we divide the quantity by _____ and multiply by _____.

Example 3

8 Without using your calculator, use simple division and multiplication with whole numbers for the following percentage calculations.

Hint Use ÷ and × of whole numbers to calculate each %.

a 10% of $200
b 20% of $1000
c 25% of $80
d 50% of $842
e 1% of $7000
f 75% of $800
g 150% of $4000
h 120% of $550

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Example 4

9 Calculate the following percentages of the given quantities, using your calculator. Round your answers correct to one decimal place.

a 5% of 280 kg
b 11% of $432
c 12% of 620 km
d 37% of 128 litres
e 80% of 640 mL
f 150% of $12 500
g 300% of 140 kg
h 146% of 232 tonnes

APPLICATIONS

SF: 10–18 | CF: – | CU: –

10 A survey finds that 78% of high school students own a mobile phone. A school has 1180 students.

a Calculate 78% of 1180.
b Use your result from part **a** to state approximately how many students at the school would be expected to have mobile phones.

11 Tanya earns $84 000 annually and receives a 7% pay rise.

a Calculate the amount of extra money Tanya receives.
b Determine the amount that Tanya earns annually after receiving this pay increase.

12 Eddie bought a new TV marked at $780 and was given a 15% discount.

a Calculate the discount he received on the TV.
b Determine how much he paid for the TV.

13 Refer to the nutritional label shown.

a Identify the number of grams in one serve (i.e. the serving size).
b Identify the percentage of one serve that is fat (total fat).
c Calculate the number of grams in a single serve that is fat.
d Identify the percentage of one serve that is carbohydrate (total carbohydrate).

NUTRITION INFORMATION

Serves per pack: 6		**Serving Size 150g**
Avg Quantity per serve		Avg Quantity per 100g
Energy	146.4 kJ	97.7 kJ
Proteins	10 g	6.7 g
Fat, Total	1 g	0.67 g
– Saturated Fat	0 g	0 g
Carbohydrate	20 g	13.3 g
– Dietary Fibre	14 g	9.4 g
– Sugars	6 g	4 g
Sodium	6 mg	4 mg

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e Calculate the number of grams in a single serve that is carbohydrate.
f Identify the percentage of one serve that is dietary fibre.
g Calculate the number of grams in a single serve that is dietary fibre.

Example 5 ★**14** Ryan scores 60% on his Maths test. If the test was out of 50 marks, calculate how many marks Ryan obtained.

★**15** Jake drives 25% of the 1184 km distance from Longreach to Port Douglas. Calculate the distance that Jake drives.

★**16** In Queensland, there are 28 000 students studying Year 11 and 12, where 30% of these students study Essential Maths. Calculate the number of students in this group who study Essential Maths.

★**17** April's taxable income for the past financial year was $136 000 and she must pay 2% of this income as a Medicare levy. Calculate how much Medicare levy April must pay.

★**18** Henry deposited $8000 in his bank account and after 1 year received 12% in interest.
a Calculate how much interest Henry received after 1 year.
b What is Henry's account balance when the interest is added to his deposit?

PROBLEM-SOLVING

19 Three health companies, GoodFeeling, IMGood and HappyHealth, employ 6000, 7360 and 9430 people, respectively. The percentages of women employed in the three companies are 62%, 57% and 43%, respectively. Determine which company has the highest number of female employees.

Hint 'Respectively' means in the same order.

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3B Determining an amount as a percentage of another amount

LEARNING GOALS

- Express one quantity as a percentage of another quantity for two amounts with the same units and with different units
- Calculate one quantity as a percentage of another quantity in real-world contexts

Why is it essential to calculate one amount as a percentage of another?

As noted in the previous section, percentages make things easier to compare than fractions with different denominators. First though, we need to express one quantity as a percentage of another.

For example, a person calculates percentages to compare the various proportions of their total income spent on rent, food, transport and other living expenses.

A chef calculates percentages to record and compare each ingredient's share of the total cost and profit per recipe.

A business calculates percentages to compare the proportions of its total costs spent on expenses such as rent, wages, buying new stock and paying tax. A business also calculates the percentage each part of the business contributes to its overall profit.

WHAT YOU NEED TO KNOW

- To express one quantity (A) as a percentage of another quantity (B):
  1. Write each quantity in the same units, if necessary.
  2. Write quantity A as a fraction of quantity B: $\frac{A}{B}$.
  3. Multiply the fraction by 100 to calculate the percentage.
- When we calculate a percentage, the answer includes the symbol %.
  - For example: Write 45 marks as a percentage of 75 marks.

$$\frac{45}{75} \times 100 = 60\%$$

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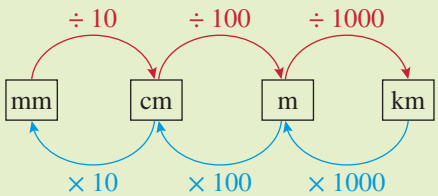
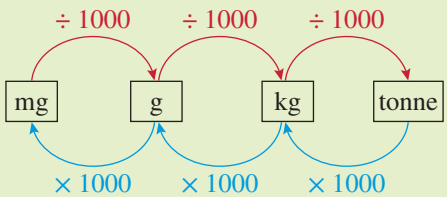
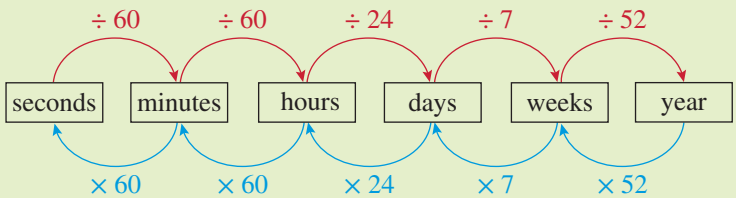
- Larger units × factor to find smaller units. Smaller units ÷ factor to find larger units.
- Conversion of **length** units



- Conversion of **mass** units



- Conversion of **time** units



- Other unit conversions:
  - 1000 mL = 1 litre
  - 100 cents = $1

Example 6 Expressing one quantity as a percentage of another quantity when both quantities have the same units

Use an appropriate calculation to express each of the following as percentages, giving answers to one decimal place.

a 30 km out of 240 km **b** 11 litres out of 84 litres

WORKING	THINKING
a $\frac{30}{240} \times 100 = 12.5\%$	Write 30 out of 240 as a fraction. Then multiply by 100 to calculate the percentage.

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WORKING	THINKING
b $\frac{11}{84} \times 100 = 13.0952\%$ $= 13.1\%$	Write 11 out of 84 as a fraction. Then multiply by 100 to calculate the percentage. As the second decimal place is a 9, round up the first decimal place to 1.

Example 7 Expressing one quantity as a percentage of another quantity when each quantity has different units

For each of the following, first express the quantities with the same units and then calculate the first amount as a percentage of the second amount. Round your answers to one decimal place where appropriate.

a 750 m out of 5 km

b 18 hours out of 1 week

WORKING	THINKING
a $5 \text{ km} = 5 \times 1000 \text{ m}$ $= 5000 \text{ m}$	Convert the larger unit (km) to the smaller unit (m). [km ($\times$ 1000) $\rightarrow$ m]
$\frac{750}{5000} \times 100 = 15\%$	Write 750 out of 5000 as a fraction, then multiply by 100.
b $1 \text{ week} = 1 \times 7 \times 24$ $= 168 \text{ h}$	Convert the larger unit (weeks) to the smaller unit (hours). [week ($\times$ 7) $\rightarrow$ days ($\times$ 24) $\rightarrow$ hours]
$\frac{18}{168} \times 100 = 10.7142\%$ $= 10.7\%$	Write 18 out of 168 as a fraction, then multiply by 100. As the second decimal place is 1, which is < 5, round the answer down to the first decimal place of 7.

Example 8 Calculating one quantity as a percentage of another quantity in a real-world context

a Beth solved 52 problems of the 60 problems presented in her university exam. Calculate the percentage of problems that Beth solved. Round your answer to one decimal place.

b Levi has a student savings account with $20. Levi receives 98 cents in interest. Calculate the percentage interest rate for this account. Round your answer to one decimal place.

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WORKING	THINKING
a $\frac{52}{60} \times 100 = 86.66\%$ $= 86.7\%$	Write 52 out of 60 as a fraction. Then multiply by 100 to write this fraction as a percentage. As the second decimal is > 5, round up the first decimal place to 7.
b $\$20 \times 100 = 2000$ cents $\frac{98}{2000} \times 100 = 4.9\%$	Convert the larger unit ($) to the smaller unit (cents). Write 98 out of 2000 as a fraction. Then multiply by 100 to write this fraction as a percentage.

Exercise 3B

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in the following statements.

a To express one quantity (A) as a percentage of another quantity (B), we:

i Write each quantity in the _____ units, if necessary.

ii Write quantity A as a _____ of quantity B: $\frac{\square}{\square}$.

iii Find that fraction of _____%: $\frac{\square}{\square} \times$ _____ ____.

b When we calculate a percentage, the answer includes the symbol _____.

2 Without a calculator, multiply by 100 to express each of the following fractions as percentages.

a $\frac{1}{2}$ **b** $\frac{1}{4}$ **c** $\frac{3}{10}$ **d** $\frac{2}{5}$

e $\frac{7}{20}$ **f** $\frac{27}{1000}$ **g** $\frac{35}{200}$

Hint Divide by the HCF to simplify.
e.g. $\frac{3}{50} \times 100$
$= \frac{3}{\cancel{50}_{1}} \times \cancel{100}^{2}$
$= 6\%$

Example 6

3 Use an appropriate calculation to express each of the following as percentages, giving answers to one decimal place where appropriate.

Hint Multiply the fraction by 100 to calculate the percentage.

a 5 kg out of 40 kg
b 6 litres out of 60 litres
c $24 out of $80
d 40 MB out of 320 MB
e 14 grams out of 91 grams
f 51 litres out of 310 litres
g $325 out of $125
h 112.5 m out of 90 m

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FUNDAMENTALS [COMPLEX]

Example 7

4 For each of the following:

i Use multiplication or division to express the quantities with the same units.

ii Use an appropriate calculation to express the first amount as a percentage of the second amount. (Give answers to one decimal place where appropriate.)

Hint: Convert each larger unit to the smaller unit.

a 500 g out of 4 kg
b 750 mL out of 3 L
c 1200 m out of 8 km
d 30 minutes out of 2 hours
e 42 cents out of $10
f 5 days out of 3 weeks
g 90 cm out of 50 m
h 880 mm out of 3.2 m
i 480 seconds out of $\frac{1}{2}$ an hour
j 20 hours out of 1 week

APPLICATIONS

SF: 5–10 | CF: 11–15 | CU: 16, 17

5 Becky drives 495 km out of the 1375 km from Birdsville to Dalby. Becky's friends Olly and Kate share the remaining driving equally.

a Calculate the percentage of the trip driven by Becky.

b Use your result from part **a** to determine what percentage of the trip is driven by Olly and by Kate.

6 Brian receives a $240 discount on a lawn mower because it is the demonstration model. It was originally $699.

a Write the discount as a fraction of the original cost of the mower.

b Use the fraction from part **a** to determine the percentage discount that Brian receives.

Example 8a

★7 Anna scored 60 marks out of 80 marks on her Science exam. Calculate the percentage that Anna got correct.

★8 A 'pound' cake weighs approximately 450 grams. The cake contains 250 grams of flour. Calculate the percentage of the pound cake that is flour.

Hint: Start with a fraction, then times by 100.

★9 Of the 120 students in Year 11, 55 students study Design. Calculate the percentage of Year 11 students studying Design.

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★10 A holiday costs $1100 for accommodation, $580 for airfares and $720 for food. Calculate each one of the following costs as a percentage of the total holiday costs.

a accommodation

b airfares

c food

Example 8b ★11 Carlene ran 800 m of a 2 km race.

a Use multiplication to convert 2 kilometres to metres.

b Calculate the percentage of the race that Carlene ran.

★12 In the mixing of cement, 2 tonnes of cement includes 600 kg of sand. Determine the percentage of the cement mixture that is sand.

Hint First convert to the same units.

★13 In a 400 m relay swimming event, Otto swam 400 m in 48 seconds. If the total relay team took 3.5 minutes, determine the percentage of the total relay time that Otto swam.

★14 Trish is charged a credit card fee of 90 cents for a $36 online purchase of movie tickets. Calculate the percentage of the purchase price that is the credit card fee.

★15 Noah uses 225 mL of green cordial to make up 3 L of cordial drink. Calculate the percentage of the drink that is the green cordial.

★16 Dana uses her dishwasher for 1.5 hours every two days. Calculate the percentage of time in a fortnight that Dana uses her dishwasher.

PROBLEM-SOLVING

★17 In a 2 kg packet of mixed nuts, 400 grams are pistachios, 420 grams are almonds, 540 grams are cashews and the rest are walnuts. Determine the percentage of walnuts in the packet.

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3C Applying percentage increases and decreases, including mark-ups and discounts COMPLEX

LEARNING GOALS

- Apply percentage increases to calculate price mark-up amounts
- Apply percentage discounts to calculate price reductions
- Calculate the Goods and Services Tax (GST)
- Calculate selling prices that include the GST
- Apply percentage increases and decreases in various real-world situations

Why is it essential to understand percentage increases and decreases?

We live in a society that seems to always have something on sale. Understanding how stores mark up products to make profits and also use discounts to entice people to buy helps us to determine which items are the best value for money.

Store managers, retail assistants and customers all use percentages to calculate mark-up and discounted prices.

WHAT YOU NEED TO KNOW

- The **cost price** is the amount of money that a business pays for a product.
- When a business sells a product, they make money (i.e. a profit) by having marked up (i.e. increased) the cost price.
- The **mark-up** is usually given as a percentage increase of the cost price.
- To calculate the **marked price** from a given cost price, the mark-up amount, in $ (found from the percentage increase), is added to the cost price of the item.

$$\text{Mark-up amount in \$} = \% \times \text{cost price}$$
$$\text{Marked price} = \text{cost price} + \text{mark-up amount}$$

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- The marked price is also called the selling price and the retail price.
  - For example: A laptop with cost price \$600 is marked up by 37.5%.

$$\text{Mark-up} = \frac{37.5}{100} \times 600 = \$225$$

$$\text{Marked price} = \$600 + \$225 = \$825$$

- A **discount** is usually given as a percentage decrease of the marked price.
- To calculate the **discounted price** or sale price of an item, the amount of discount is subtracted from the marked price.

$$\text{Discount amount in \$} = \% \times \text{marked price}$$

$$\text{Discounted price} = \text{marked price} - \text{discount}$$

  - For example: A handsaw with a marked price of \$50 is discounted by 20%.

$$\text{The discount is } \frac{20}{100} \times 50 = \$10.$$

$$\text{The discounted price is } \$50 - \$10 = \$40.$$

- The Goods and Services Tax (**GST**) is a 10% government tax added to the selling price of goods and services.
  - For example: A gas bill of \$275.87 has $\text{GST} = \$275 \times \frac{10}{100}$

$$= \$27.587 = \$27.59$$

The final amount to pay is \$275.87 + \$27.59 = \$303.46.

- Round all money answers to two decimal places.

Example 9 Applying a percentage increase to calculate the mark-up amount [Complex]

An electric bike costs a business \$3700 and is marked up by 8.25%. Calculate:

a the mark-up amount

b the marked price of the electric bike

WORKING	THINKING
a $\text{Mark-up} = \frac{8.25}{100} \times \$3700$	$8.25\% = \frac{8.25}{100}$. Find this fraction of the cost price.
$= \$305.25$	
b $\text{Marked price} = \$3700 + \$305.25$	Marked price = cost price + mark-up Add the amount of increase to the original cost.
$= \$4005.25$	Round to two decimal places for all money answers.

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Example 10 Applying a percentage decrease to calculate the discounted price [Complex]

A set of junior golf clubs has a marked price of $387 and is discounted by 13%. Apply this percentage decrease to calculate:

a the discount, in dollars

b the discounted price of the product

WORKING	THINKING
a $\text{Discount} = \frac{13}{100} \times \$387$ $= \$50.31$	Calculate 13% of $387.
b $\text{Discounted price} = \$387 - \$50.31$ $= \$336.69$	Discounted price = marked price − discount amount Round to two decimal places for all money answers.

Example 11 Calculating the GST percentage increase [Complex]

Calculate the GST applicable on a fry pan that is sold for $29.85.

WORKING	THINKING
$\text{GST} = \frac{10}{100} \times \$29.85$ $= \$2.99$	10% of $29.85 is $29.85 ÷ 10 = $2.985 = $2.99. Round to two decimal places for all money answers.

Example 12 Applying a percentage increase or decrease in a real-world context [Complex]

Mandy purchases a Rubik's cube on eBay for $12, including postage. She then marks it up by 80% to sell at her garage sale. Determine the selling price of Mandy's Rubik's cube at the garage sale.

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WORKING	THINKING
Mark-up $= \frac{80}{100} \times \$12$ $= \$9.60$	Find 80% of $12.
Marked price $= \$12 + \$9.60$ $= \$21.60$	Add the new amount to the original value.
Mandy will sell the Rubik's cube for $21.60.	Write the answer as a sentence.

Exercise 3C

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in the following statements.

- **a** The _____ price is the amount that a business pays for a product.
- **b** A business makes a _____ by _____ up the _____ _____.
- **c** The _____-__ is usually given as a _____ increase of the cost price.
- **d** The _____ price is also called the selling price and the _____ price.
- **e** A discount is usually given as a percentage _____ of the _____ price.
- **f** To calculate the _____ price or sale price of an item, the amount of discount is _____ from the marked price.
- **g** The Goods and Services Tax, also known as the _____, is a __% government tax added to the selling price of goods and services.

Example 9

2 For each of the following, apply the given percentage increase to calculate:

i the mark-up amount **ii** the final marked price

- **a** Mark-up a cost price of $1200 by 10%.
- **b** Mark-up a cost price of $400 by 15%.
- **c** Mark-up a cost price of $160 by 12.5%.
- **d** Mark-up a cost price of $35 by 20%.
- **e** Mark-up a cost price of $2500 by 28%.
- **f** Mark-up a cost price of $58 by 150%.
- **g** Mark-up a cost price of $350 000 by 3.69%.
- **h** Mark-up a cost price of $5250 by 9.75%.
- **i** Mark-up a cost price of $199 by 82.6%.

Hint The mark-up amount is a % of the cost price.

Hint Marked price = cost price + mark-up

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Example 10

3 For each of the following, apply the given percentage decrease to calculate:

i the discount amount **ii** the final sale price

a Discount a marked price of $125 by 20%.

Hint: Sale price = marked price – discount

b Discount a marked price of $695 by 10%.

c Discount a marked price of $7500 by 12%.

d Discount a marked price of $500 by 15%.

e Discount a marked price of $240 by 25%.

f Discount a marked price of $78 by 4.5%.

g Discount a marked price of $299 by 17.25%.

h Discount a marked price of $28 800 by 8.9%.

Example 11

4 Australia's GST is currently 10% of the selling price of goods or services rendered. Without using a calculator, calculate the GST applicable to the following amounts.

a $50 **b** $285

c $3000 **d** $56

e $174 **f** $69.90

g $16 999 **h** $426 500

Hint: Finding 10% is the same as ÷ 10.

GST stands for Goods and Services Tax.

APPLICATIONS

SF: – | CF: 5–12 | CU: 13, 14

Example 12

5 At DenimStop, Lillie wishes to buy a pair of jeans marked at $69.95. If the store offers her a 15% discount, calculate:

a the discount amount that Lillie will receive

b the final selling price of the jeans

Hint: Sale price = marked price – discount

6 Keith wants to surprise his wife with a new gold bracelet, which has a marked price of $295. The store has a sale offering 30% off the marked price.

a Calculate the discount that Keith will receive.

b What is the bracelet's final selling price?

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7 James runs a mowing business. He wants to keep $45 for each average mowing job, yet he must also charge the customer GST and send this tax to the Australian Taxation Office.

a Calculate the amount of GST payable on $45.

b Determine how much James should charge for each average mowing job if the price he quotes includes the GST.

Prices given to customers must, by law, include the GST in the price.

★ 8 **a** In New Zealand the GST is 15%. If a bungee jump in New Zealand costs $99 plus GST, calculate the total cost for one bungee jump.

b If a bungee jump in Australia costs $105 plus GST, compare the overall cost of a jump in Australia with a jump in New Zealand.

★ 9 Telio imports 50-inch televisions from Taiwan at a cost of $295 each and then sells them in its stores. Telio marks up these televisions by 150%. Determine the marked price of each television.

★ 10 Rick bought two tickets for a total of $240 to a sell-out World Cup final. Unfortunately, he can't go and decides to sell them and make a profit of 25%. Determine the selling price of the tickets.

★ 11 A cabinet maker makes bookshelves, each costing her $80 for materials. The cabinet maker sells the bookshelves to a furniture retail business, adding a 75% mark-up on her materials cost. The retailer sells each bookshelf to customers with a 120% mark-up on the cost price. Calculate the retailer's marked price of each bookshelf.

Hint The price is being increased each time.

★ 12 Erik wishes to buy a new red baseball cap online. He can buy one from either the Square Shop, where it is marked at $48 and a 20% discount is being offered, or the Triangle Shop, where it is marked at $42 and a 12% discount is being offered. Both online stores are offering free delivery.

a At which online store is the hat cheaper?

b Determine how much Erik will save buying it from the cheaper online store compared with the other store.

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★ **13** Letisha is planning a holiday on a cruise ship. At Go-quick Travel she sees a 7-night cruise for $890 and they are offering a 10% discount if she books today. At Time-off Travel Letisha sees the same cruise advertised at $829 with a 5% discount if she books today.

a Determine which travel agent has the best deal.

b Calculate how much Letisha will save by booking with Time-off Travel if she books today.

The percentage occupancy of cruise ship cabins directly affects the cruise liner's overall percentage profit.

PROBLEM-SOLVING

14 The local supermarket purchases a box of 60 specialty chips packets for $48. The store manager marks up the packets by 120%. In the last week before the use-by date, the store manager reduces the price by 50%, as any that have not sold by the use-by date must be thrown away.

Determine what profit, if any, the supermarket made if it sold 18 of the packets at full price, 28 at the discounted price and had to throw away the rest.

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3D Determining overall change from multiple percentage changes COMPLEX

LEARNING GOALS

- Calculate new amounts after multiple percentage changes
- Determine overall price changes in real-world contexts

Why would overall change from multiple percentage changes be considered essential knowledge?

Our economy runs on a network for distributing manufactured or farmed products and finally making them available to consumers. Distribution channels include producers, importers, wholesalers, retailers, agents, dealers and the internet. It is important to realise that at every level of exchange within the network, all those involved have expenses to cover, requiring various profit margins.

If a forklift driver earns a 2% pay increase, giving him a $1000 p.a. gross pay increase, and this amount is decreased by 32.5% tax, his net pay increase is $675.

When a worker receives a pay rise, the accountant first increases the wage by the given percentage and then this new pay amount is decreased by the tax percentage, resulting in the final net (i.e. 'take-home') pay.

WHAT YOU NEED TO KNOW

- Multiple percentage changes can be applied to calculate the overall change from an original amount.

  Overall change in $ = final amount in $ − original amount in $

- Each percentage change, which can be either a percentage increase or a percentage decrease, must be calculated step-by-step.

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- The first percentage change is calculated using the original amount and then, after that, each percentage change is calculated on the previous changed amount.
- Consecutive percentage changes can be any combination of percentage increases and decreases.
  - For example: \$400 is increased by 50% and then decreased by 10%.

    Increase = 50% of \$400 = \$200 ← + \$ amount for % increase.

    New amount = \$400 + \$200 = \$600

    Decrease = 10% of \$600 = \$60 ← – \$ amount for % decrease.

    Final amount = \$600 – \$60 = \$540

    Overall change = final amount – original amount
    = \$540 – \$400 = \$140
- If the overall change is negative, then a loss has been made.

Example 13 Calculating new amounts from multiple percentage changes

Determine the overall change in the following.

a \$130 is increased by 15% and then that amount is increased by 22%. State the amount of loss or gain.

b \$1000 is increased by 20% and then that amount is decreased by 20%. State the amount of loss or gain.

WORKING	THINKING
a First increase:	Write 'First increase'.
$\frac{15}{100} \times \$130 = \$19.50$	Calculate 15% of \$130.
\$130 + \$19.50 = \$149.50	Add that amount to the original amount.
Second increase:	Write 'Second increase'.
$\frac{22}{100} \times \$149.50 = \$32.89$	Calculate 22% of the new amount of \$149.50.
\$149.50 + \$32.89 = \$182.39	Add that amount to the \$149.50.
Overall change:	Write 'Overall change'.
\$182.39 – \$130 = \$52.39	Overall change = final amount – original amount
A gain of \$52.39.	The positive result indicates a gain of \$52.39.

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WORKING	THINKING
b Increase:	Write 'Increase'.
$\frac{20}{100} \times \$1000 = \$200$	Calculate 20% of $1000.
$\$1000 + \$200 = \$1200$	Add that amount to the original amount.
Decrease:	Write 'Decrease'.
$\frac{20}{100} \times \$1200 = \$240$	Calculate 20% of the new amount of $1200.
$\$1200 - \$240 = \$960$	Subtract the amount $240 from $1200.
Overall change:	Write 'Overall change'.
$\$960 - \$1000 = -\$40$	Overall change = final amount – original amount
Overall, a loss of $40.	The negative result shows there is a loss of $40.

Example 14 Determining overall price changes in real-world contexts [Complex]

a Riley made a cubby house, which cost him $180 in timber, paint and nails. He sold it, making a profit of 125%. Calculate Riley's profit and his selling price.

b George bought Riley's cubby house but left it out in the weather, causing the paint to fade and the wood to deteriorate. George then sold it at a loss of 60%. Calculate the amount of money George lost and his selling price.

c Determine the overall change in price of the cubby house, from the amount it cost Riley to build to George's selling price.

WORKING	THINKING
a Riley's profit $= \frac{125}{100} \times \$180$	Use words at each step to indicate what is being calculated.
$= \$225$	
Riley's selling price $= \$180 + \$225$	Calculate 125% of $180. Then add that amount to the original amount.
$= \$405$	
b George's loss $= \frac{60}{100} \times \$405$	Calculate 60% of the new amount of $405.
$= \$243$	
George's selling price $= \$405 - \$243$	Then subtract that amount from $405.
$= \$162$	

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WORKING	THINKING
c Overall change in price $= \$162 - \$180$ $= -\$18$	Overall change = final amount – original amount The negative result shows there is a loss of $18.
George sold the cubby at a loss of $18 compared to Riley's cost of the materials to build it.	Write your answer as a sentence.

Exercise 3D

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in the following statements.

- **a** Multiple _____ changes can be applied to calculate the overall _____ from the original amount.
- **b** _____ merely add and subtract all the percentages.
- **c** Each percentage _____ or _____ must be calculated _____ by _____.
- **d** The first percentage change is calculated using the _____ amount, and then each _____ change is calculated on the _____ changed amount.
- **e** Overall change = ____ _____ – _____ _____

Example 13

2 Determine the overall change that has occurred when:

- **a** $40 is increased by 60% and then increased further by 25%.
- **b** $122 is increased by 20% and then increased further by 12%.
- **c** $546 is increased by 24% and then increased further by 7.5%.
- **d** $11 800 is increased by 35% and then increased further by 55%.
- **e** $300 is increased by 20% and then decreased by 30%.
- **f** $340 000 is increased by 6.5% and then decreased by 9.75%.
- **g** $548 is decreased by 12% and then increased by 10.75%.
- **h** $250 is decreased by 20% and then increased by 10%.

Shipping costs increase the price of imported goods by a percentage.

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3 **a** Increase $100 by 20%.
b Increase $100 by 10% and then increase that result by a further 10%.
c Explain why increasing $100 by 10% and then by 10% again is not the same as increasing $100 by 20%.

APPLICATIONS

SF: –	CF: 4–12	CU: –

4 One apple costs the farmer 22 cents to produce ready for sale. The farmer sells the apple with a price increase of 75% to the retailer, and the retailer sells it to the customer with a price increase of 175%.
a Calculate the cost of the apple for the retailer.
b Calculate the price of the apple to the customer.

5 Heidi was struggling with Maths and scored 52 out of 100 in her exam. She studied hard and improved her mark by 28% of her previous test result. Heidi saw that she could do the work and was so pleased with her increased result that she studied even harder and had extra help from the teacher. She improved a further 38% on her second test result.
a Calculate Heidi's final mark out of 100.
b Determine how many marks out of 100 Heidi improved overall.

6 Mr and Mrs Capps built their house in 1960 for $15 000. They sold it in 2010 with an increase of 3200%.
a Determine the price that the house sold for in 2010.
b In 2015 the house was renovated and then sold for a profit of 21%. Calculate the selling price of the renovated house.
c Determine by what amount the house has increased in value from when it was built in 1960 to the 2015 sale.

7 Hannah is a childcare worker in Stanthorpe, Queensland, earning a gross wage of $42 000 per annum.
a Hannah is given a 1.5% pay increase. Calculate her gross wage increase.
b Hannah's employer must pay 32.5% tax on her wage increase. Calculate the actual net increase in pay that Hannah receives.

Hint Gross income is the amount before tax. Net income is the amount after tax.

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Example 14

★ 8 Nikita purchased a bicycle from jBay for $328, including postage, and tried to sell it for a profit of 50% at the markets. By the end of the day she had discounted her price on the bike by 30%. How much profit or loss did Nikita make?

★ 9 A prawn farmer grows and produces prawns at a cost of $4/kg. The farmer sells the prawns to the fish market with a percentage increase of 70%. The fish market sells them to the retailer with a mark-up of 35%, and the retailer sells the prawns to the customer with a mark-up of 110%. Calculate the overall cost increase, from farmer to customer, of 1 kg of prawns.

Prawn farms, Cairns. Over 40% of Australian seafood is produced by scientifically managed farms, which apply maths in every area of operation.

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★ **10** Fenton's water tank contains 12 000 litres of water. It doesn't rain for a month and, from using the water for his garden, the tank's water volume has decreased by 81%. Calculate the overall change in water volume of the tank, in litres.

★ **11** Giselle the grape farmer harvested 63 tonnes of grapes. Unfortunately, a heat wave meant that she lost 17.24% of the grapes due to spoilage. The truck carrying the rest to market rolled over and another 47% were destroyed. Determine how many tonnes of grapes Giselle lost altogether.

★ **12** Sanjay has $17 400 worth of shares in insurance stocks. The market is very volatile and the shares initially increase by 28%. A bad credit report sees the shares decrease by 40% and news of a merger with a larger company means the shares increase by a further 22.8%. Calculate the overall percentage increase or decrease in the value of Sanjay's shares.

Company shares are bought and sold daily on the stock market, resulting in many percentage changes.

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3E Calculate simple interest for different rates and time periods COMPLEX

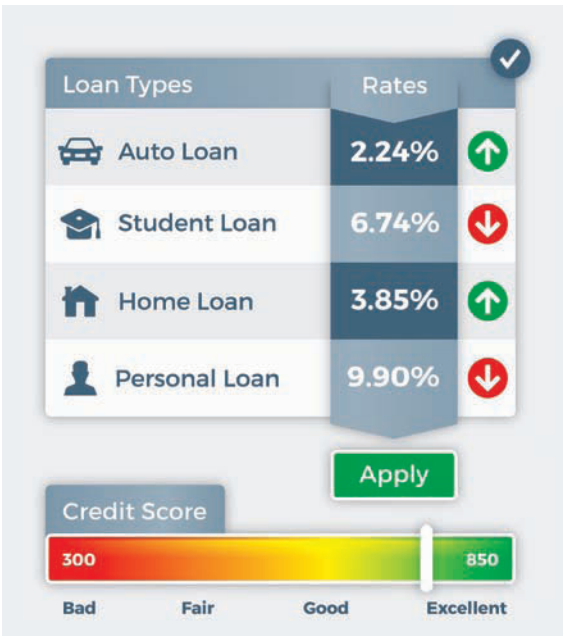
LEARNING GOALS

- Convert time periods to years
- Convert interest rates to rates p.a. (per annum; i.e. per year)
- Calculate simple interest using the simple interest formula
- Calculate simple interest in real-world contexts

Why is an understanding of simple interest essential?

Using simple interest is essential to understanding how interest rates work in the world of finance. The knowledge of how simple interest is calculated shows how money lenders make profits using interest rates. It is also required knowledge for developing an understanding of compound interest in the future.

Calculating the total cost of any loan must include repaying the loan plus the interest to be paid. Applying the skills of interest calculations is a priority for personal financial success.



Interest rates can vary depending on what the loan is used for and the borrower's credit rating.

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WHAT YOU NEED TO KNOW

- The simple interest formula

$$I = Pin$$

where I is the simple interest, in $.
P is the principal amount or initial amount, in $.
i is the interest rate p.a. (i.e. per year), as a decimal.
n is the number of years.

It is more common for interest rates to be given as a percentage interest rate per annum. You can use the figure for the percentage interest rate in the formula if you divide the decimal interest rate per annum i by 100. The formula then becomes:

$$I = \frac{Pin}{100}$$

where now i = percentage interest rate per annum.

- Conversion of time units

1 year = 4 quarters = 12 months = 26 fortnights = 52 weeks = 365 days

Example 15 Converting time periods to years

Calculate the value of n, in years, if the time period is 21 months.

WORKING	THINKING
$n = 21 \div 12$ $= 1.75$ years	Recall that 12 months = 1 year. Divide the time period by 12 to get the number of years.

Example 16 Converting interest rates to rates per annum

Calculate the value of i, the interest rate per year, if the interest rate per time period is 0.25% per week.

WORKING	THINKING
$i = 0.25\% \times 52$ $= 13\%$ p.a.	Recall that 52 weeks = 1 year. Interest rate per week × 52 = rate p.a. (per year)

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Example 17 Calculating simple interest using the formula

Calculate the simple interest to be paid on a loan of $420 000 over a total of 25 years at 0.3% per fortnight.

WORKING	THINKING
$P = \$420\,000$	Start by listing P, i and n.
$i = 0.3\% \times 26$ $= 7.8\%$ p.a	Convert interest per period to interest p.a. (per year). Recall that 26 fortnights = 1 year, so multiply 0.3 by 26.
$n = 25$ years	
$I = \frac{Pin}{100}$	Write the formula.
$I = \frac{420\,000 \times 7.8 \times 25}{100}$	Substitute $P = \$420\,000$, $i = 7.8\%$ and $n = 25$ years into the formula.
$I = \$819\,000$	Calculate the interest.

Example 18 Calculating simple interest in real-world contexts

Nadia invests $17 400 of her savings for 9 months in a term deposit that is paying an interest rate of 7.45% p.a. Calculate how much interest she will receive.

WORKING	THINKING
$P = \$17\,400$	Start by listing the values for P, i and n.
$i = 7.45\%$	
$n = 9 \div 12 = 0.75$	To convert months to years, divide by 12.
$I = \frac{Pin}{100}$	Write the formula.
$I = \frac{17\,400 \times 7.45 \times 0.75}{100}$	Substitute $P = \$17\,400$, $i = 7.45\%$ and $n = 0.75$ years into the formula.
$I = \$972.23$	Calculate the interest and round your answer to two decimal places.

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Exercise 3E

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words or symbols in the following statements.

i When using the simple interest formula, $I = \frac{Pin}{100}$:

a I is the simple _____ in __.

b P is the _____ amount or _____ amount, in $.

c i is the interest _____.

d n is the number of _____.

e **p.a.** is short for ____ _____.

ii 1 year = __ quarters = __ months = __ fortnights = __ weeks = ___ days

Example 15

2 Calculate the value of n, in years, if the time period is:

a 6 quarters **b** 3 quarters

c 18 months **d** 27 months

e 52 fortnights **f** 65 fortnights

Hint n = number of years
4 quarters = 1 year
12 months = 1 year
26 fortnights = 1 year
52 weeks = 1 year

Example 16

3 Calculate the value of i, the interest rate per year, if the interest rate per time period is:

a 1.5% per month

b 0.75% per month

c 0.125% per fortnight

d 0.875% per fortnight

e 0.2% per week

f 0.7% per week

Hint i is the rate p.a. (per year).

Example 17

4 Use the formula $I = \frac{Pin}{100}$ to calculate the simple interest to be paid on the following loans.

a $4000 over 2 years at 8.5% p.a.

b $8400 over 3 years at 4% p.a.

c $15 600 over 5 years at 3.75% p.a.

d $38 000 over 7 years at 4.5% p.a.

e $5500 over 4 years at 8% p.a.

f $13 200 over 5 years at 6.5% p.a.

Hint Start by writing:
$P =$
$i =$
$n =$
$I = \frac{Pin}{100}$

5 Use the formula $I = \frac{Pin}{100}$ to calculate the simple interest to be paid on a loan amount of:

a $21 000 over a total of 4.5 years at 0.6% per month

b $3800 over a total of 3 years at 2% every 6 months

c $5200 over a total of 4 years at 2% per quarter

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6 Calculate the simple interest earned on an amount of $420 000 invested for 25 years at 0.3% per fortnight.

7 Calculate the simple interest earned on:
- **a** $2700 invested over a total of 30 months at 12.75% p.a.
- **b** $10 800 invested over a total of 13 weeks at 15% p.a.
- **c** $20 000 invested over a total of 13 fortnights at 9% p.a.

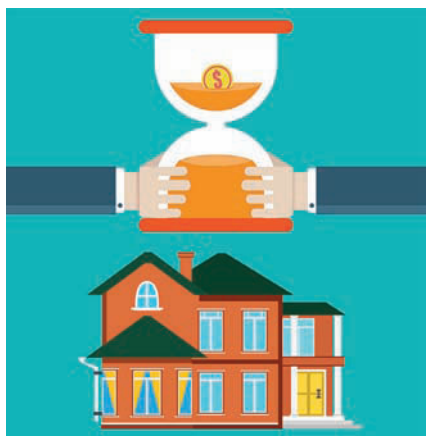
8 Calculate the simple interest to be paid on $4000 borrowed for 39 weeks at 3.76% p.a.

APPLICATIONS

SF: – | CF: 9–14 | CU: 15, 16

Example 18 **★9** Howard borrows $25 000 to be repaid over 3.5 years at a simple interest rate of 13.5% p.a. Using the simple interest formula, calculate how much Howard will need to repay in total.

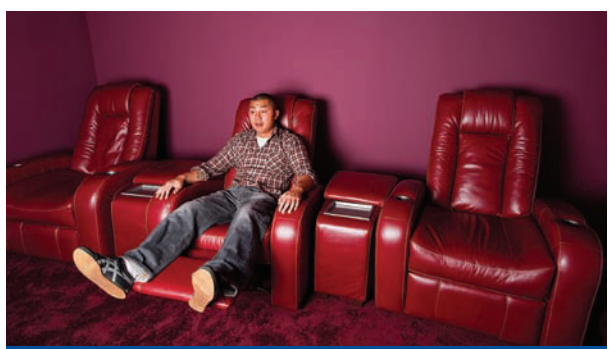
★ 10 Rachel invests $8200 for 18 months, earning 3.8% p.a. Use the simple interest formula to calculate the amount of interest Rachel will receive on her investment.



★ 11 Simon borrows $320 000 to buy a house. Use the simple interest formula to calculate an estimate of the total interest he will pay for a loan period of 25 years at a rate of 0.5% per month.

★ 12 Alexandrea obtains a short-term loan of $1800 to pay for her car to be repaired. Determine the total she will need to repay in 1 months' time if the simple interest rate on this loan is 28% p.a.

★ 13 Jay buys some new recliner chairs for his home theatre. They cost $5800 and Jay takes up the store's offer of a 30-month loan at 19.6% p.a. to pay for them. Use the simple interest formula to calculate the total amount Jay will pay for the lounge chairs.



Taking out a loan to buy items greatly increases the purchase price.

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★ **14** Ethan invests $68 000, earning a simple interest rate of 0.35% per month. Calculate how much interest he will earn in:

a 1 year **b** 1 day

★ **15** Rhiannon wishes to buy a car worth $6200. She is offered two options for finance.
Option 1: A short-term loan of $6200 with repayment over 33 months at 11.5% p.a.
Option 2: A longer-term loan of $6200 with repayment over 5 years at 7.9% p.a.
Determine which of the two loans is the cheapest option for Rhiannon if she borrows $6200.

16 Penny inherits $20 000 and invests it in a bank term deposit for 6 months. The following spreadsheet compares the two different interest rates that the bank offers, with interest paid either every fortnight or every month. Copy the information into a spreadsheet and fill in the rest of the document.

a The formula for C3 is = B3*6%/26. The formula for B4 is = B3 + C3. Use this information to deduce the formulas used in F3 and E4.

b Create this spreadsheet and fill down the columns to complete it.

c Use the spreadsheet to determine which is the better investment option.

	A	B	C	D	E	F	G
1	**Penny's Term Deposit**						
2		**Amount**	**Interest 6%**			**Amount**	**Interest 6.1%**
3		$20,000.00	$46.15			$20,000.00	$101.67
4	fortnight 1	$20,046.15	$46.26		Month 1	$20,101.67	$102.18
5	fortnight 2				Month 2		
6	fortnight 3				Month 3		
7	fortnight 4				Month 4		
8	fortnight 5				Month 5		
9	fortnight 6				Month 6		
10	fortnight 7				Term Deposit Total		
11	fortnight 8						
12	fortnight 9						
13	fortnight 10						
14	fortnight 11						
15	fortnight 12						
16	fortnight 13						
17	Term deposit total						
18							

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Problem-solving and modelling task

SCHOOL SURVEY: FAVOURITE SPORT

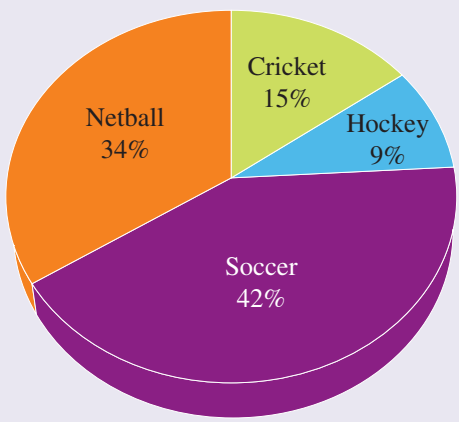
Background: Percentages are useful in analysing all kinds of statistics such as the results of surveys, where we want to compare the sizes of different parts of the results.

A survey is conducted at two different schools, Apply School and Weval School, asking students to choose their favourite sport from a choice of netball, cricket, hockey or soccer. The results are given in percentages on the pie charts shown.

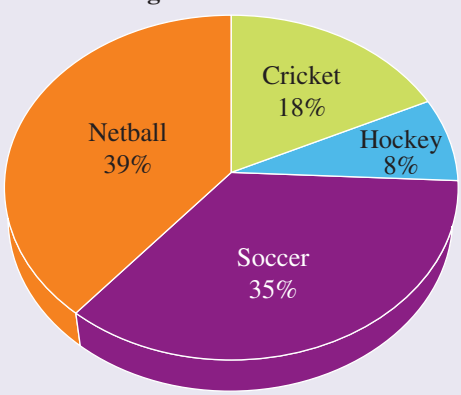
Task: You are to use your knowledge of percentages to analyse the pie charts and write a report discussing the popularity of the sports, from least popular to most popular, based on the total number of students in the two schools.

The explanation you provide must include the total number of students who voted for each sport, as well as the overall percentage of students who voted for that sport.

Apply High School 400 students



Weval High School 600 students



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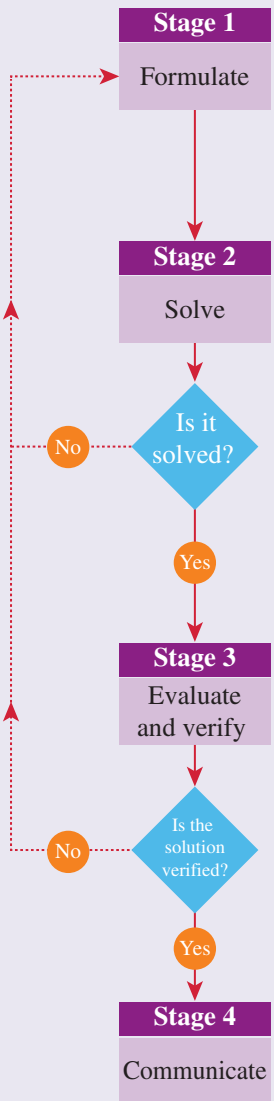
To complete this task, follow the problem-solving workflow diagram below and use the steps listed as a guide.



Stage 1: Formulate

1. For each sport, identify the percentage of students at Apply High who voted for that sport.
2. For each sport, identify the percentage of students at Weval High who voted for that sport.

Stage 2: Solve

3. For each sport, calculate the number of students at Apply High who voted for that sport.
4. For each sport, calculate the number of students at Weval High who voted for that sport.
5. For each sport, determine the total number of students who voted for that sport.
6. Calculate the overall percentage of student votes for each sport.

Stage 3: Evaluate and verify

7. Determine the least popular sport to the most popular sport, according to total number of students.
8. Determine the least popular sport to the most popular sport, according to overall percentage.
9. Compare the orders of popularity to confirm that both orders agree with each other.

Stage 4: Communicate

10. Comment on your findings in a short report, discussing the popularity of the sports in order from least popular to most popular.

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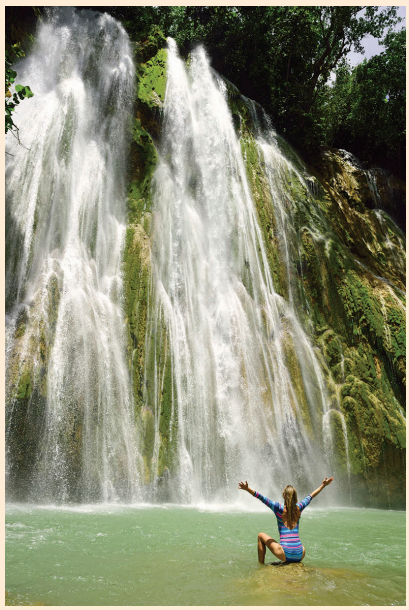
Puzzle



An interesting percentage fact is that about 70% of an adult human is water.

Another interesting percentage fact is that 95% describes the amount of 'what'?

To find out what, solve the following questions and use the answer to fill in the question letter above the answer in the grids below.

Calculate the following percentages using your calculator.

A $\$400 \times 3\%$

E $840\,\text{kg} \times 15\%$

Use an appropriate calculation to express the first quantity as a percentage of the second.

R 3 cm out of 20 cm

N 120 kg out of 200 kg

Calculate the following mark-up or discount for each of the following.

L \$600 is discounted by 20%

E \$36 is marked up by 250%

Calculate the GST on the following amounts.

Y \$650

H \$180

Determine the overall change that has occurred when:

I 80 litres is increased by 30% and then increased again by 50%.

S \$100 is increased by 10% and then decreased by 20%.

J Calculate the value of n, in years, if the time period is 132 months.

T Calculate the simple interest to be paid on a credit card amount of \$400 over 2 years at 16% p.a.

W Calculate the simple interest to be paid on \$1000 over 27 months at 6% p.a.

135	12	128	90	15	156	60	12

11	90	120	120	65	126	156	88	18

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Chapter checklist

☐ I understand the fundamentals of percentages.

1 Convert 35% to a simplified fraction.
2 Calculate 12.5% of $4320.
3 Cody scored 72% on his Design Arts test. Calculate how many marks he scored out of 50.

☐ I can determine an amount as a percentage of another amount. [Complex]

4 Calculate $32 of $80 as a percentage.
5 Calculate 500 grams of 2.5 kg as a percentage.
6 Raelene ran 400 m of a 1.6 km relay race. Determine the percentage of the race that she ran.

☐ I can apply a percentage increase or decrease, including mark-ups and discounts. [Complex]

7 Calculate the mark-up on $1350 when marked up by 30%.
8 Calculate the discount on $2700 when discounted by 12.5%.
9 Calculate the GST on a house sale of $598 000.

☐ I can determine the overall change that occurs when given multiple percentage changes. [Complex]

10 Determine the overall change when $724 is increased by 38% and then increased by 24%.
11 Determine the overall change when $278 000 is decreased by 18% and then increased by 45%.
12 Milk costs the farmer 28 cents per litre to produce. The farmer sells it with an 80% mark-up to the retailer, which then marks up it up by another 150%. Calculate the total cost increase of the milk, per litre.

☐ I can calculate simple interest for different rates and time periods.

13 Calculate the value of n, in years, when the time period is 39 fortnights.
14 Calculate the value of i, the annual interest rate, if the interest rate per time period is 0.25% per week.
15 Calculate the simple interest earned on $2800 invested over a total of 18 months at 6.8% p.a.

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Chapter review

All questions in the Chapter Review are assessment-style.

Simple Familiar

Section 3A

1 There are 155 students in Years 11 and 12 at Crib Island High School. According to a recent survey, 60% of the students have a part-time job. Determine how many students have part-time jobs.

2 Rex earns $72 500 a year and must pay 2% of his taxable income as a Medicare levy. Calculate how much Medicare levy Rex must pay.

Section 3B

3 Sandy scores 36 out of 40 on her Biology multiple-choice test. Calculate the percentage of questions that Sandy got correct.

4 Gemma and her friends drove from Gladstone to the Gold Coast, with Gemma driving 347 km of the 596 km trip. Calculate the percentage of the trip that Gemma drove. Round your answer to the nearest whole number.

Complex Familiar

Section 3B

5 Reggie uses 750 mL of orange juice to make up 2.5 litres of fruit punch. Calculate the percentage of the drink that is orange juice.

6 Zoe plays video games for 21 hours in 1 week. Calculate the percentage of time in a week that she plays video games.

Section 3C

7 Dianne buys a house for $180 000 and renovates it. She sells it many years later for a profit of 40%. Calculate the selling price of the house.

8 Ali buys electric motors at $72 each. He then adds on a mark-up of 160% when he sells them. Calculate the profit on each motor as a percentage of the selling price.

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Section 3C **9** Aimee bought two tickets for $240 to see the Queensland Ballet Company perform. Unfortunately, she can't go and decides to sell them at a discount of 22%. Calculate Aimee's selling price of the ballet tickets.

Section 3D **10** Farmer Joe harvests macadamia nuts at a cost of $1.70 per kilogram and sells them with a 150% mark-up to the markets. The market sells them to the retailer with a 75% mark-up. The retailer marks up the macadamia nuts another 200%. Calculate the overall change in the cost of the macadamia nuts, per kilogram.

Section 3E **11** Gavin invests $37 000 over a total of 3 years, earning 8.6% p.a. simple interest. Calculate the amount of interest he receives.

12 Susan invests $734 over a total of 4 years, earning 2.3% per month. Calculate the amount of interest she receives.

Complex Unfamiliar

Section 3D **13** Medusa purchases an old collectable car from a farmer for $12 000. She spends a further 60% of the purchase price to restore the car. Medusa advertises the car for sale after adding a mark-up of 80% to the total amount she has already spent on the car.
Calculate the amount the car's value has increased by when compared with the original purchase price.

Section 3E **14** Eliza invests $4200 at an interest rate of 4.8% p.a. over 20 months. Calculate how much money Eliza will have at the end of the 20 months.

15 Sam borrows $24 000 for a new car, which is to be repaid over 54 months at 13.8% p.a. simple interest. He must pay back the loan in 54 equal monthly payments. Calculate the total amount that Sam must pay back to the bank, including interest.

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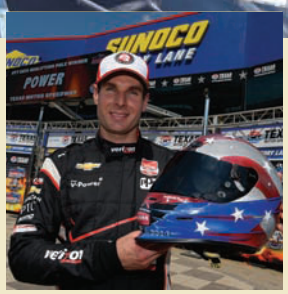
4 Classifying, presenting and interpreting data



Maths for an IndyCar racing driver: Will Power

Will Power is an Australian professional motorsports driver who currently competes in the IndyCar Series in the USA, driving for Team Penske. He was the 2014 IndyCar Series champion and won the 2018 Indianapolis 500.

Tell us a bit about your job. What does a typical day look like?

Generally, a race weekend consists of three to four days out of the week. The first day is a prep day, where I go over data from the previous year's race with my engineer and, depending on the track, I will do a track walk to look for any changes that could affect the car. The second and third days consist of practise sessions and qualifying, which also include numerous sponsor appearances and debriefs with my race engineer to go through the data from the session. The final day is race day, where we generally have a warm-up, sponsor appearances and then the race is generally about 2 hours long. On non-race weekends, my job consists of staying in shape, training six days a week, travelling for sponsor appearances and meeting with my race engineer to prepare for upcoming races.

What maths did you study at school?

Honestly, it's been so long I can't remember. Probably, the basic maths like algebra and problem-solving.

How do you use maths in your job? Could you give some examples?

Maths is used in a number of ways in racing. For example, to calculate ride heights based on the set-up, weather and downforce. It is also used with race strategy to calculate the fuel window and fuel prediction, and simulating car-handling balance from the set-up, etc. The maths we use to calculate fuel windows for race strategy is predominantly algebra. When it comes to simulation of the car and set-up for the car, the maths we use is more calculus and differential equations.

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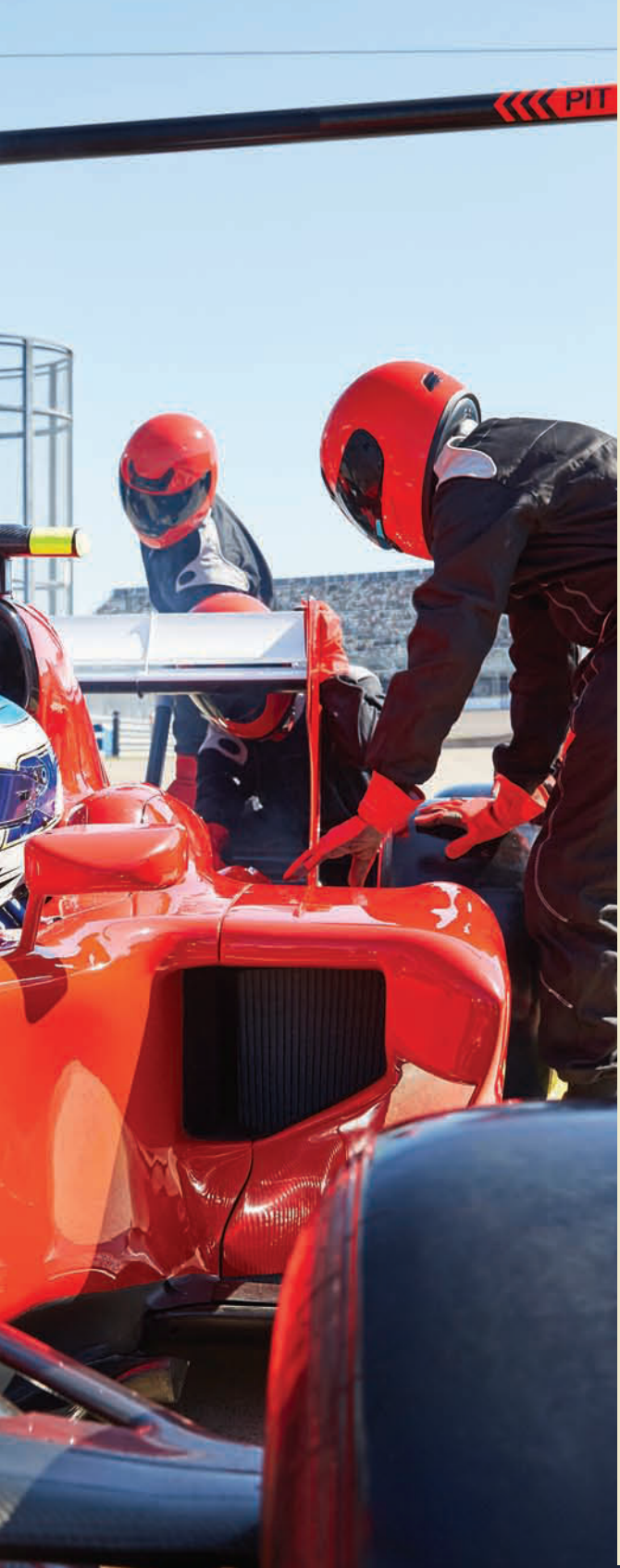

In this chapter

4A Classifying data

4B Categorical data: tables and graphs

4C Numerical data: frequency distribution tables and histograms

4D Dot plots and stem-and-leaf plots

4E Outliers

4F Comparing how data is presented **[complex]**

Problem-solving and modelling task

Puzzle

Chapter Checklist

Chapter Review

Syllabus reference

Unit 1 Topic 2

Classifying data (3 hours)

In this subtopic, students will:

- identify examples of categorical data
- identify examples of numerical data.

Data presentation and interpretation (8 hours)

In this subtopic, students will:

- display categorical data in tables and column graphs
- display numerical data as frequency distribution tables, dot plots, stem-and-leaf plots and histograms
- recognise and identify outliers from a dataset
- compare the suitability of different methods of data presentation in real-world contexts **[complex].**

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Pre-test

1 The favourite colours are recorded for a class of students.

Colours	Votes
red	5
blue	8
green	13
purple	11

a How many favourite colours are there?
b How many students are in the class?
c How many students voted green as their favourite colour?
d Do more than half the class have blue or green as their favourite colour?
e How many more students have purple as their favourite colour than blue?

2 The following table shows the frequency of the number of siblings of the students in the same class as that of Question **1**.

No. of siblings	Frequency
0	12
1	18
2	5
3 or more	2

a Does the number of students in this table match the number of students in Question **1**?
b How many students have no siblings?
c How many students have two or more siblings?
d How many students have two or fewer siblings?
e How many more students have one sibling than no siblings?

A link to a HOTmaths lesson is provided in the Interactive Textbook to revise this topic.

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4A Classifying data

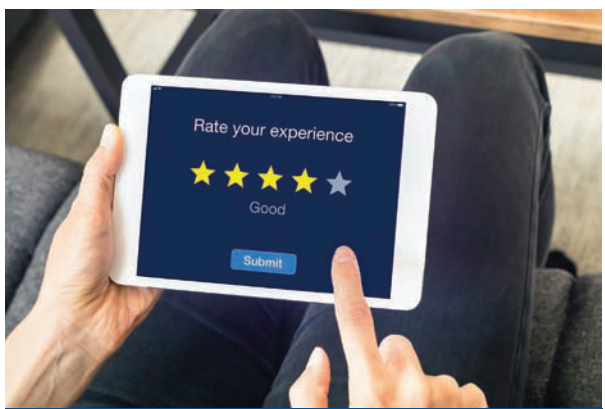
LEARNING GOAL

- Identify data as either categorical or numerical

Why is it essential to know how to classify data?

We live in a society that is driven by data. We are constantly being asked to 'rate our experience' at restaurants and shops. Data about the way we shop, what we are buying and what we are interested in is constantly being collected by store loyalty card programs and the web browsers we use to make a search. The way we use data depends on its type. If we surveyed people's favourite pizza topping, the data would consist of names (i.e. words) such as *pepperoni, ham and pineapple, meatlovers*, etc. However, we would not be able to calculate an 'average' for this data, as there are no numbers on a ham and pineapple pizza! But we can still display the responses in a graph or table.

On the other hand if we surveyed the number of siblings our classmates have, the data would consist of numbers.



We are constantly being asked to rate our experience with shops, restaurants and hotels. This data is used to ensure that products we are interested in are marketed back to us.

WHAT YOU NEED TO KNOW

- **Data** is a collection of information that could be either words or numbers.
  - There are two main types of data: categorical (sometimes called qualitative) and numerical (sometimes called quantitative).
- **Categorical data** is data that can be grouped into separate categories. The data collected will consist of **words** and each category has a word name.
  - For example: favourite pizza toppings; car colours.
- **Numerical data** uses **numbers** for data that has been counted or measured.
  - For example: the number of siblings; the height of students.

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Example 1 Identifying data as categorical or numerical data

Classify the following data as categorical or numerical data.

a weight of babies
b income
c favourite football team
d star rating of a restaurant
e type of car

WORKING	THINKING
a numerical	The weight of a baby would be measured in grams. This is a **number**; e.g. 3567 grams.
b numerical	Income is stated in dollars. This is a **number**; e.g. $45 000.
c categorical	The data responses for teams would be **words**; e.g. Broncos or Cowboys.
d numerical	The data would be the **number** of stars; e.g. 5 stars.
e categorical	The data for type of car would be **words**; e.g. hatchback

Exercise 4A

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in each of the following.

a **Data** is a collection of information that could be _____ or _____.
b Data that consists of **words** is called _____.
c Data that consists of **numbers** is called _____.

2 A cricket app polls fans about various aspects of the game via their device. In a Test match against England, six questions and the results of the poll (i.e. the data that was collected) are summarised on the following page. For each question polled, decide if the data that was collected is numerical (numbers) or categorical (words).

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a Do the Australians have enough runs?
Yes 18% No 82%

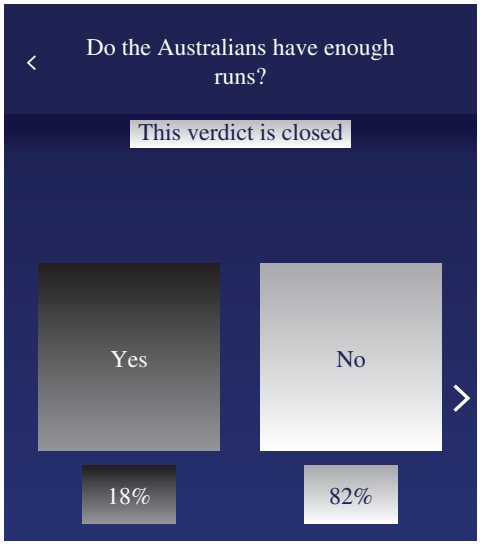
b What total should Australia be happy with?
336 runs

c Should England take the new ball?
Yes 74% No 26%

d Who's your favourite Marsh brother?
S Marsh 55% M Marsh 45%

e Should Australia make any changes for Game 2 at the Gabba?
Yes 84% No 16%

f What lead does Australia need to declare?
286 runs



APPLICATIONS

SF: 3–6 | CF: 7–8 | CU: –

Example 1 ★3 Classify each type of data as categorical or numerical. Give two possible responses for each.

a how you travelled to school today
b how many brothers/sisters you have
c your preferred style of music
d your favourite take-away food

Hint Categorical data has word names.

★4 Traffic Police collect data to monitor road safety. Classify each type of data as categorical or numerical. Give two possible responses for each.

a cause of an accident
b during a shift the number of drivers detected using a mobile phone while driving
c speed of cars as they pass a speed camera
d type of drug detected in a roadside test
e blood alcohol content (BAC) of drivers at a random breath test
f result of random roadside drug test

Hint Numerical data has been counted or measured.

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★**5** A group of people are surveyed about pet ownership. For each question, decide if the survey collects numerical or categorical data. Give two possible responses to each question.

a Do you own a pet?
b How many pets do you have?
c What type of pet do you own?
d How much does your pet weigh?
e How old is your pet?
f Where does your pet sleep?
g How much do you spend on pet food each week?
h How often do you feed your pet each day?
i How many legs does your pet have?
j What is the main colour of your pet?

★**6** Travellers coming into Australia must complete both sides of an Incoming passenger card, shown below.

Incoming passenger card • Australia

PLEASE COMPLETE IN ENGLISH WITH A BLUE OR BLACK PEN

- Family/surname
- Given names
- Passport number
- Flight number or name of ship
- Intended address in Australia

State

- Do you intend to live in Australia for the next 12 months? Yes No
- If you are **NOT an Australian citizen:**
  - Do you have tuberculosis? Yes No
  - Do you have any criminal conviction/s? Yes No

PLEASE ✕ AND ANSWER EVERY QUESTION – IF UNSURE, Yes ✕

Are you bringing into Australia:

1.	Goods that may be prohibited or subject to restrictions, such as medicines, steroids, illegal pornography, firearms, weapons or illicit drugs?	Yes	No
2.	More than 2250mL of alcoholic beverages or 25 cigarettes or 25g of tobacco products?	Yes	No
3.	Goods obtained overseas or purchased duty and/or tax free in Australia with a combined total price of more than AUD$900, including gifts?	Yes	No
4.	Goods/samples for business/commercial use?	Yes	No
5.	AUD$10,000 or more in Australian or foreign currency equivalent? **Note:** If a customs or police officer asks, you must report travellers cheques, cheques, money orders or other bearer negotiable instruments of any amount.	Yes	No
6.	Meat, poultry, fish, seafood, eggs, dairy, fruit, vegetables?	Yes	No
7.	Grains, seeds, bulbs, straw, nuts, plants, parts of plants, traditional medicines or herbs, wooden articles?	Yes	No
8.	Animals, parts of animals, animal products including equipment, pet food, eggs, biologicals, specimens, birds, fish, insects, shells, bee products?	Yes	No
9.	Soil, items with soil attached or used in freshwater areas e.g. sports/recreational equipment, shoes?	Yes	No
10.	Have you been in contact with farms, farm animals, wilderness areas or freshwater streams/lakes etc in the past 30 days?	Yes	No
11.	Were you in Africa, South/Central America or the Caribbean in the last 6 days?	Yes	No

DECLARATION
The information I have given is true, correct and complete. I understand failure to answer any questions may have serious consequences.

YOUR SIGNATURE Day Month Year

TURN OVER THE CARD

English

SAMPLE

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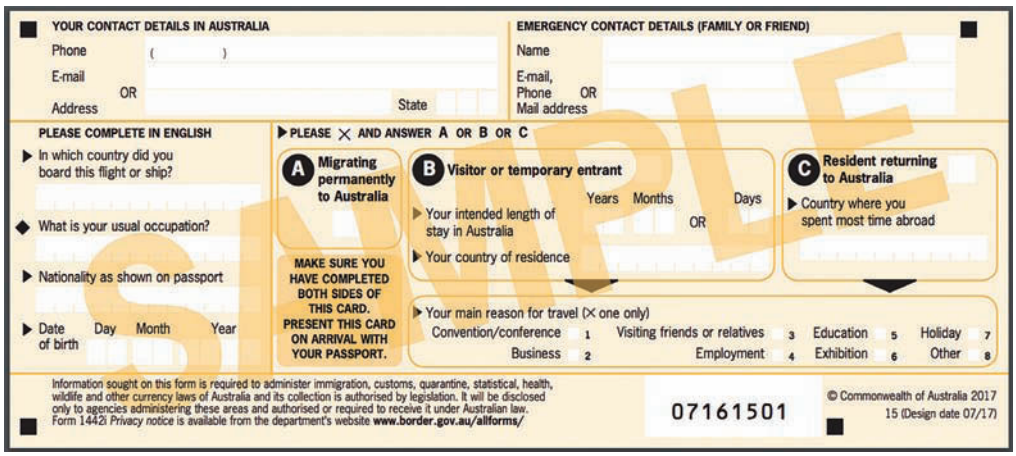
YOUR CONTACT DETAILS IN AUSTRALIA
Phone
E-mail
OR
Address
State
EMERGENCY CONTACT DETAILS (FAMILY OR FRIEND)
Name
E-mail, Phone OR Mail address
PLEASE COMPLETE IN ENGLISH
In which country did you board this flight or ship?
What is your usual occupation?
Nationality as shown on passport
Date of birth Day Month Year
PLEASE X AND ANSWER A OR B OR C
A Migrating permanently to Australia
B Visitor or temporary entrant
Years Months Days
Your intended length of stay in Australia
OR
Your country of residence
C Resident returning to Australia
Country where you spent most time abroad
MAKE SURE YOU HAVE COMPLETED BOTH SIDES OF THIS CARD. PRESENT THIS CARD ON ARRIVAL WITH YOUR PASSPORT.
Your main reason for travel (X one only)
Convention/conference 1
Visiting friends or relatives 3
Education 5
Holiday 7
Business 2
Employment 4
Exhibition 6
Other 8
Information sought on this form is required to administer immigration, customs, quarantine, statistical, health, wildlife and other currency laws of Australia and its collection is authorised by legislation. It will be disclosed only to agencies administering these areas and authorised or required to receive it under Australian law. Form 1442i Privacy notice is available from the department's website www.border.gov.au/allforms/
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15 (Design date 07/17)
SAMPLE

For each of the following, classify the data collected as categorical or numerical.

a Migrating permanently to Australia

b Your intended length of stay in Australia

c Your country of residence

d Your main reason for travel

e Country where you spent most time abroad

★7 You are asked by your year level coordinator to survey your classmates about their wishes for the school formal next year.

a Design two questions that collect numerical data.

b Design two questions that collect categorical data.

★8 A Physical Education class is given the task of surveying the Year 11 group about their participation in team sports.

a Design two questions that collect numerical data.

b Design two questions that collect categorical data.

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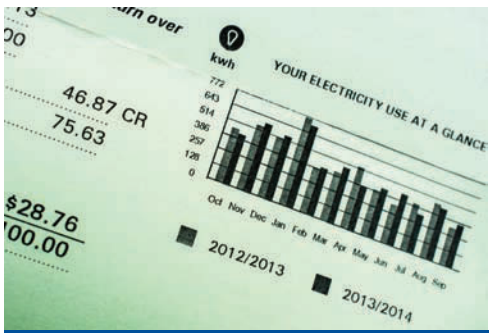
4B Categorical data: tables and graphs

LEARNING GOALS

- Organise categorical data into a frequency table
- Present categorical data in a column graph drawn by hand
- Identify an appropriate scale to use for a column graph
- Create a column graph, using Excel, to present categorical data

How is the organisation and presentation of categorical data essential?

Organising data after it has been collected allows us to quickly see trends in the data and make conclusions about it.



Readers glance at graphs within a report before reading the whole report, to give them an overview of what they are about to read.

WHAT YOU NEED TO KNOW

- A **frequency table** displays data by showing how much data has been collected in each category.
  - **Tally** marks allow you to count data as it is collected. For ease of counting, tally marks are grouped in sets of five by putting a diagonal mark across a group of four: 𝍸
  - The **frequency** column is the subtotal for the category.
  - The **total** gives a way of checking that all the data has been recorded.
- A **column graph** is used to represent categorical data.
  - The horizontal axes will show the different categories.
  - The vertical axes will show the frequency. It is sensible to start at zero and count up in factors of 10; that is, count up in increments of 1, 2 or 5. If the frequency is bigger, you could count in 10s, 20s or 50s, or even 100s, 200s or 500s for really large datasets.

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- Generally, aim to make your graph have between 5 and 10 steps on the frequency when deciding on which scale to use.
- The columns do not touch each other.
- Use a ruler.
- Label the axes and give your graph a title.

Example 2 Organising categorical data into a frequency table and presenting it in a hand-drawn column graph

Forty people are asked which is their favourite Queensland NRL team. The responses are given below.

Broncos	Cowboys	Titans	Titans	Cowboys	Cowboys	Broncos	Cowboys
Cowboys	Titans	Broncos	Cowboys	Broncos	Cowboys	Broncos	Cowboys
Cowboys	Broncos	Cowboys	Broncos	Broncos	Broncos	Cowboys	Broncos
Titans	Broncos	Cowboys	Cowboys	Cowboys	Broncos	Cowboys	Broncos
Titans	Cowboys	Titans	Cowboys	Titans	Cowboys	Broncos	Titans

a Construct a frequency table to record the data, using the headings 'Category', 'Tally' and 'Frequency'.

b Construct a column graph for the data.

WORKING

a

Category	Tally	Frequency
Broncos	𝍸 𝍸 ||||	14
Titans	𝍸 |||	8
Cowboys	𝍸 𝍸 𝍸 |||	18
Total	**40**	**40**

THINKING

Construct table with the headings as asked and list the teams in the category column.
Work through the data, in order. Place a tally mark next to the category. Mark every fifth one with a diagonal line through the previous four to group the five together and make counting easier.
Count the tally marks and record the frequency for each category.
Check that the frequency total adds up to 40.

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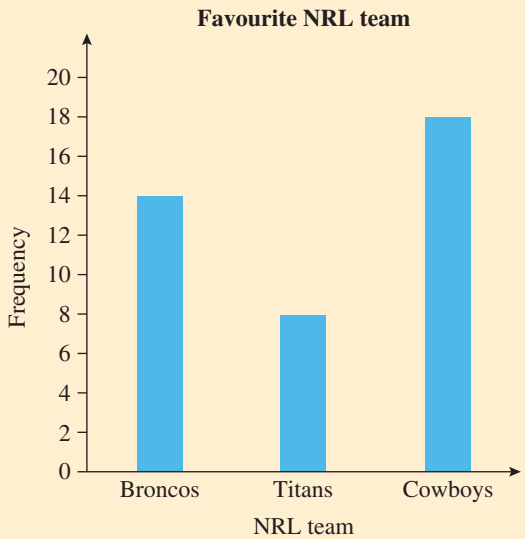
b Counting up in 1s will take 18 steps
→ too many steps. ☒
Counting up in 2s will take nine steps
→ OK. ☑
0, 2, 4, …, 16, 18, 20

We want 5 to 10 steps and to count only in 1s, 2s or 5s.
Identify the most suitable option.
The largest frequency is 18.



Draw up a set of axes with the frequency going up in 2s to just past 18.
For each category, draw a column so its height matches the frequency.
Leave a space between each column.
Label each column along the bottom axis.
Label the axes.
Give your graph a heading.

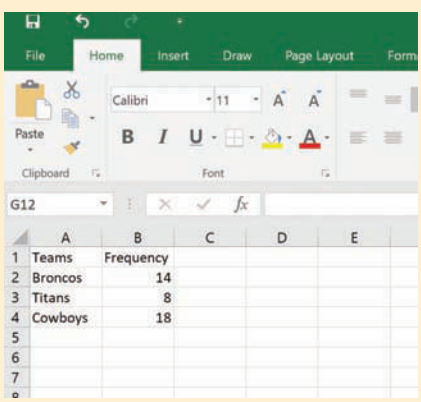
Example 3 Creating a column graph, using Excel, to present categorical data

Use Excel to produce a graph of the data that was collected in **Example 2**.

Category	Tally	Frequency
Broncos	𝍸 𝍸 ||||	14
Titans	𝍸 |||	8
Cowboys	𝍸 𝍸 𝍸 |||	18
Total	**40**	**40**

WORKING | **THINKING**

a



Type the information from the frequency table into the columns, as shown.

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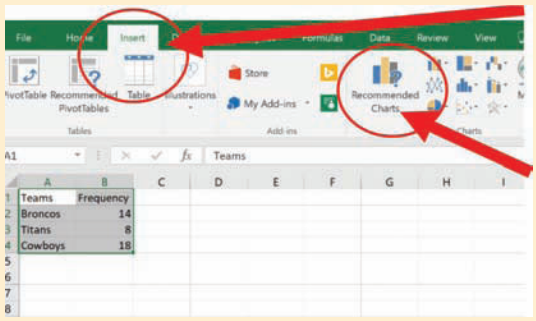
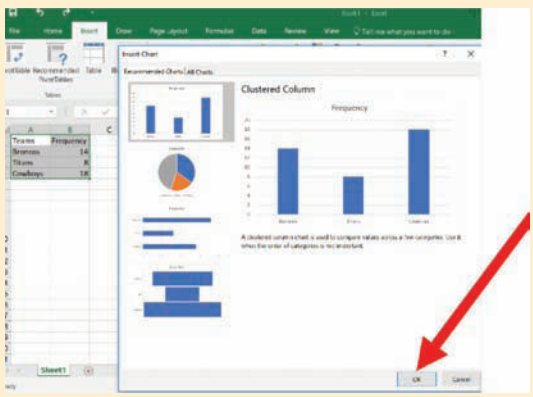


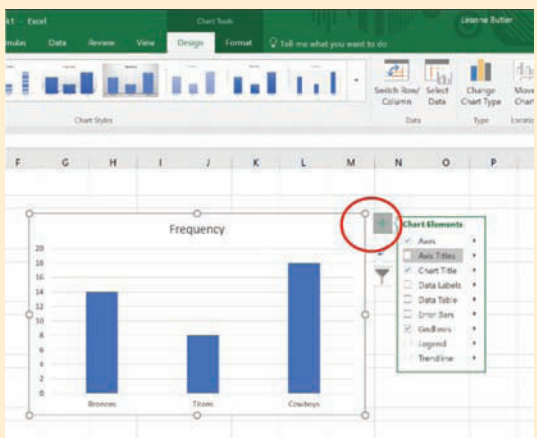
Highlight the data.
Click on the 'Insert' tab.

Then click on 'Recommended Charts'.

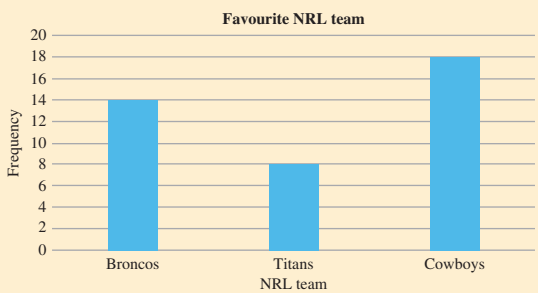


Select the type of graph you would like.
In this case, we will pick the first one.

Click on 'OK'.



You should now have the start of your graph. We need to get some axes labels.
Click anywhere on your graph and three icons will appear at the right of the graph.
Select '+' to add chart elements.
☑ Axis Titles to add labels to your horizontal and vertical axes.



Type in the title and axes labels, as shown.

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Exercise 4B

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in the following statements.

- **a** A _____ **table** displays data by showing how much data has been collected in each category.
- **b** **Tally** marks allow you to _____ data as it is collected.
- **c** For ease of counting, tally marks are _____ in sets of five by putting a diagonal mark across a group of four.
- **d** The _____ column is the subtotal for the category.
- **e** The **total** gives a way of _____ that all the data has been recorded.
- **f** A **column graph** is used to represent _____ data.
- **g** Generally, aim to make your graph have between ____ and ____ steps on the frequency when deciding on which scale to use.

Example 2

2 Some data is collected about people's preferred snack.

Snack preference	Tally	Frequency
packet of chips	𝍸 III	
muesli bar	𝍸 𝍸 𝍸 I	
hot dog	𝍸 𝍸	
potato wedges	IIII	
pizza slice	𝍸 𝍸 𝍸 𝍸 II	

- **a** Complete the frequency column.
- **b** Determine how many people prefer:
  - **i** potato wedges
  - **ii** a muesli bar
- **c** Identify the largest frequency.
- **d** Determine how many steps it will take to reach the highest frequency:
  - **i** if you count up in 1s
  - **ii** if you count up in 2s
  - **iii** if you count up in 5s
- **e** Decide upon the most suitable scale to count with to reach the highest frequency.

Hint A suitable scale has 5 to 10 steps.

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3 The data presented at right shows the favourite colour of a group of people.

Colour	Tally	Frequency
pink	𝍸 𝍸 IIII	14
blue	𝍸 III	8
yellow	𝍸	5
green	I	1
red	IIII	4
orange	𝍸 IIII	9
purple	𝍸 II	7
	Total	48

a Determine how many more people chose pink than yellow.

b Calculate how many people chose yellow, blue or pink.

c Calculate how many people chose red or purple.

d Which is the most popular colour?

e Determine how many steps it would take to reach the highest frequency:

i if you count up in 1s

ii if you count up in 2s

iii if you count up in 5s

f Decide upon the most suitable scale to count with to reach the highest frequency.

g Construct a column graph to represent the data.

Hint Label each axis and give your graph a title.

APPLICATIONS

SF: 4–6 | CF: 7–8 | CU: –

★4 The types of vehicle passing through an intersection are recorded over 2 minutes. The observations yield the following results.

car	motorbike	truck	utility	motorbike
taxi	car	car	motorbike	car
utility	car	utility	car	truck
car	utility	bus	car	utility

a Copy and complete the frequency table to organise the data.

Category	Tally	Frequency
car		
truck		
utility		
motorbike		
bus		
taxi		
Total		

b Which is the most common vehicle passing through the intersection?

c Construct a column graph for the data.

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★5 A vet has the following appointments during her morning at the vet surgery.

a Construct a frequency table to record the animal data, using the headings 'Animal', 'Tally' and 'Frequency'.

b What is the most common type of animal treated by the vet during the session?

c Construct a column graph for the data.

Time	Name	Animal
8:30 a.m.	Fifi	cat
8:45 a.m.	Bonnie	dog
9 a.m.	Buster	dog
9:15 a.m.	Rosie	dog
9:30 a.m.	Shadow	dog
9:45 a.m.	Rattles	cat
10 a.m.	Kitty	cat
10:15 a.m.	Sherby	turtle
10:30 a.m.	Star	dog
10:45 a.m.	Misty	cat
11 a.m.	Winnie	dog
11:15 a.m.	Sunny	dog
11:30 a.m.	Hiro	dog
11:45 a.m.	Ginger	guinea pig

★6 When planning for a school camp, the Year leader surveyed the students about what they would like on the menu. The options are: lasagne (L), chicken schnitzel and chips (C), and roast beef (B).
The students' responses are given below.

L	C	B	C	B	C	C	L	B	C
C	B	C	C	B	L	C	C	L	C
B	C	L	C	C	C	B	B	L	L
C	C	B	B	B	L	C	C	B	C
C	C	C	C	B	C	L	C	C	B

a Construct a frequency table to record the data, using the headings 'Meal', 'Tally' and 'Frequency'.

b Which is the preferred meal for this Year group?

c Construct a column graph for the data.

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Example 3

7 The results of a political poll are presented in the table shown.

a Organise the information for Party into a frequency table.

b Use Excel to construct a column graph to display the preferred political party amongst the survey group.

c Organise the information for Gender into a frequency table

d Use Excel to construct a column graph to display the distribution of gender amongst the group surveyed.

Age	Party	Gendar	Income
20	ALP	Male	45 000
25	LNP	Male	39 000
45	IND	Male	56 000
35	ALP	Female	49 000
50	LNP	Female	41 000
55	IND	Female	42 000
39	ALP	Male	58 000
48	LNP	Male	55 000
30	IND	Male	46 000
27	ALP	Female	42 000
47	LNP	Female	37 000
21	IND	Female	25 000
48	ALP	Male	75 000
24	IND	Male	43 000
28	IND	Female	40 000
40	LNP	Female	31 000

8 Visitors to Australia for the 12 months ending September 2017 were from the following regions.

Region	Frequency
Oceania (New Zealand, PNG…)	1 536 000
North-West Europe (UK, France…)	1 378 300
South-East Europe (Italy, Spain…)	220 500
Americas (Canada, USA, Mexico…)	1 069 600
North Africa and the Middle East (Israel, UAE…)	124 100
South-East Asia (Thailand, Indonesia…)	1 372 400
North-East Asia (China, Japan, Korea…)	2 507 800
Southern and Central Asia (India, Pakistan…)	380 200
Sub-Saharan Africa (South Africa…)	86 400
Total	**8 675 100**

a Modify the table and round the visitor numbers for each category to the nearest 100 000.

b Use an Excel spreadsheet to construct a column graph, showing where visitors to Australia come from.

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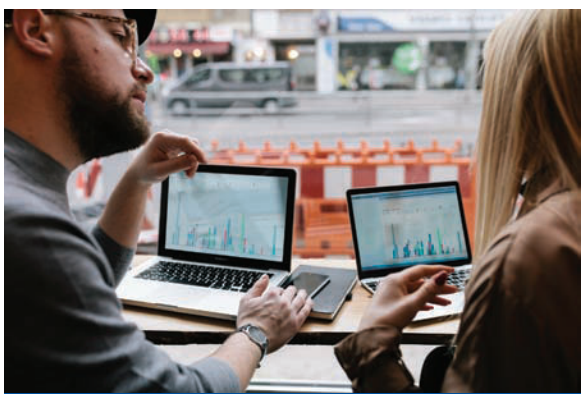
4C Numerical data: frequency distribution tables and histograms

LEARNING GOALS

- Sort numerical data into frequency distribution tables, displaying discrete data and grouped data
- Create hand-drawn histograms to display discrete data and grouped data
- Determine appropriate groupings for datasets with a large range
- Create a histogram, using Excel, to display grouped data

Why are frequency distribution tables and histograms essential?

Frequency distribution tables and histograms are powerful tools for displaying numerical data and communicating results and ideas. Visual presentations make understanding data easy and can be effective in communicating large amounts of information. Readers glance at graphs within a report before reading the whole report to give them an overview of what they are about to read.



Visual presentations are used widely to display and compare the key features of data.

WHAT YOU NEED TO KNOW

- A **frequency distribution table** displays data by showing how much data has been collected for each number or group of numbers.
  - From the previous section on frequency tables, we know there are three columns for **data, tally** and **frequency**. Adding a **total** row gives us a way of checking that all the data has been recorded.
  - When the range of data from the smallest score to the biggest score is large (i.e. more than 10), it is appropriate to group the data into intervals of 2s, 5s or 10s so that there are only between 5 and 10 lines in the table used to organise the data.

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- A **histogram** is similar to a column graph but because we are using numbers we can join the columns together, so there are no gaps.
  - Grouped numerical data vs frequency is always presented using a histogram.
  - The data scores are shown on the horizontal axis.
  - The frequency is shown on the vertical axis. Aim to make your graph have between 5 and 10 steps on the frequency scale.
  - The columns touch each other.
  - There needs to be a gap between the vertical axis and the first column.
  - Use a ruler.
  - Label each axis and give your graph a title.

Example 4 Sorting discrete numerical data into a frequency distribution table and creating a hand-drawn histogram to display discrete data

A group of students are surveyed about how many pets they have. The results are shown below.

3	2	4	2	1	2	1	1	3	6
2	1	1	1	2	2	4	1	1	0
2	2	4	3	1	1	0	2	1	1

a Organise the data into a frequency distribution table.
b What is the most common number of pets to own?
c Determine the vertical scale.
d Construct a histogram for the discrete data.

WORKING

a

Pets	Tally	Frequency
0	II	2
1	𝍸 𝍸 II	12
2	𝍸 IIII	9
3	III	3
4	III	3
5		0
6	I	1
Total	**30**	**30**

THINKING

Discrete data means individual values. Smallest number = 0, largest number = 6, so seven rows are required for the table. This is within a useable range of 5–10, so set up the table with numbers from 0 to 6 for the number of pets.
Complete your table as was done in the previous section.

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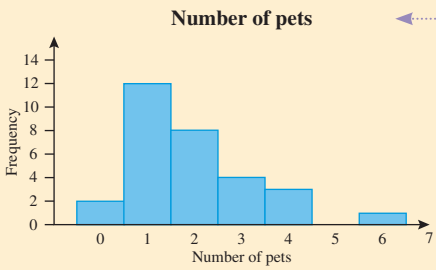
b Owning one pet is the most common.

12 is the largest frequency.

c The largest frequency is 12.
Counting up in 1s will take 12 steps → too many steps. ☒
Counting up in 2s will take six steps → OK. ☑

We need between 5 and 10 steps on the vertical axis, so a suitable scale must be found.

d



Start at 0 and count up in 2s on the vertical axis to reach 12.
Mark the number of pets on the horizontal axis at even spaces from the axes and each other.
Note that 0 is part of the dataset and is not placed at the very beginning of the axis. Even though there were no responses for five pets, this still needs to be shown.
Complete the columns using a ruler. The data label should be in the *middle* of the column and there should be *no gaps* between the columns.

Example 5 Sorting discrete numerical data into groups, and creating a frequency distribution table and a histogram to display grouped data

The date of birth is recorded for a group of students. The results are given below.

1	6	10	15	2	31	26	30	23	3
28	6	22	15	25	25	8	3	15	30
10	17	29	1	29	4	10	12	26	23
11	4	7	7	12	22	17	20	2	14
3	22	17	11	7	25	3	25	19	29

a Determine suitable groupings for the data.
b Construct a grouped frequency distribution table.
c Create a histogram for the data.

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WORKING | **THINKING**

a Smallest number = 1
Largest number = 31
Groups of 5

A frequency table needs 5–10 rows.
It is easier to count up in 1s, 2s or 5s.
Counting up in 1s will take 31 steps → too many steps. ☒
Counting up in 2s will take 16 steps → too many steps. ☒
Counting up in 5s will take seven steps → OK. ☑

b

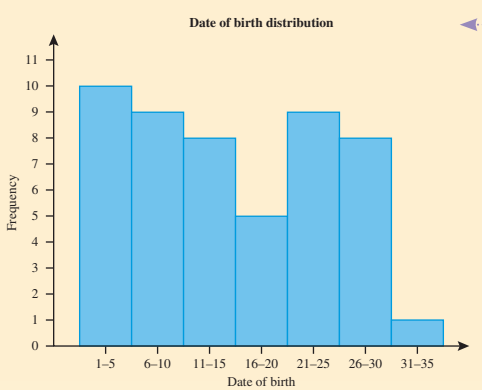
Date of birth	Tally	Frequency
1–5		
6–10		
11–15		
16–20		
21–25		
26–30		
31–35		
Total		

Create a table with the seven rows with groupings of 5. Since we are counting in 5s, the groups will end with 5, 10, 15, …, etc.

Date of birth	Tally	Frequency
1–5	𝍸 𝍸	10
6–10	𝍸 IIII	9
11–15	𝍸 III	8
16–20	𝍸	5
21–25	𝍸 IIII	9
26–30	𝍸 III	8
31–35	I	1
Total	**50**	**50**

Work through the data, placing a tally mark in the appropriate group.
Complete totals to check all the data has been recorded.

c



Leave a gap at the start of the horizontal axis and then label your evenly spaced columns in 5s to match the groups from the frequency distribution table.
Maximum frequency is 10, so it will be okay to go up in 1s on the vertical axis.
Draw columns to match data from the frequency distribution table.
Label axes and give your graph a title.

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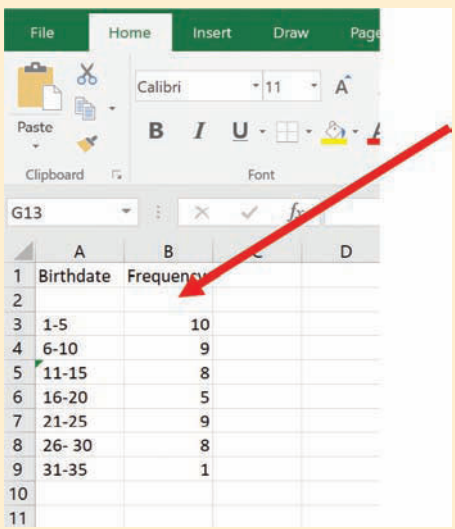
Example 6 Creating a histogram to display grouped data, using Excel

Use the data from **Example 5** to construct a histogram using Excel.

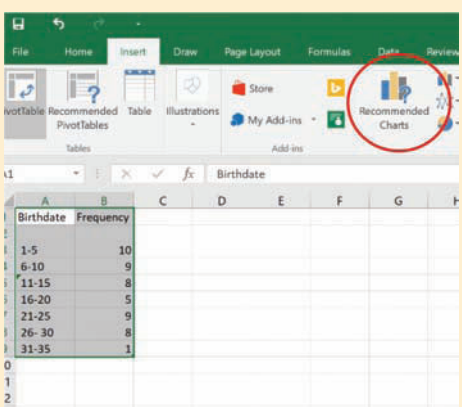
Date of birth	Tally	Frequency
1–5	𝍸 𝍸	10
6–10	𝍸 ||||	9
11–15	𝍸 |||	8
16–20	||||	5
21–25	𝍸 ||||	9
26–30	𝍸 |||	8
31–35	|	1
Total	**50**	**50**

WORKING



THINKING

Type data from your frequency distribution table into Excel.
Tip 1: Leave an empty row at the beginning of the table. This will create a space at the start of the histogram so it does not touch the vertical axis.
Tip 2: To avoid Excel autocorrecting your group range to a date, press the space bar before you type the group name.



Highlight your data.
Go to the 'Insert' tab.
Click on 'Recommended Charts'.

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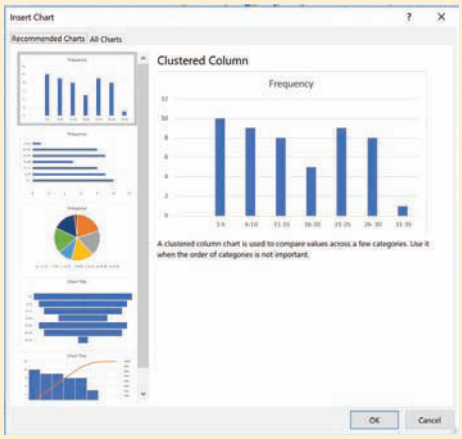
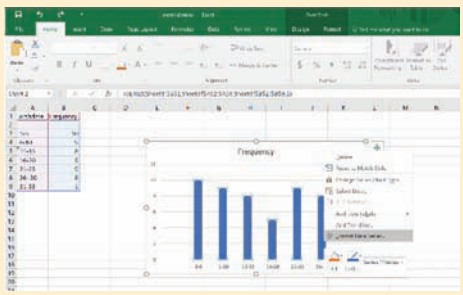
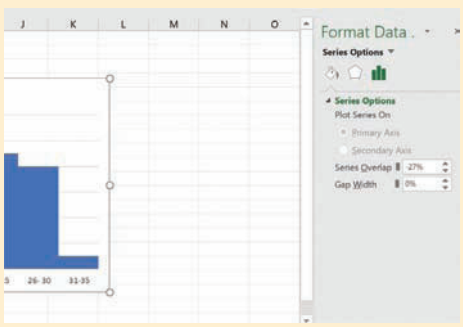

Insert Chart
Recommended Charts
All Charts
Clustered Column
Frequency
A clustered column chart is used to compare values across a few categories. Use it when the order of categories is not important.
OK
Cancel

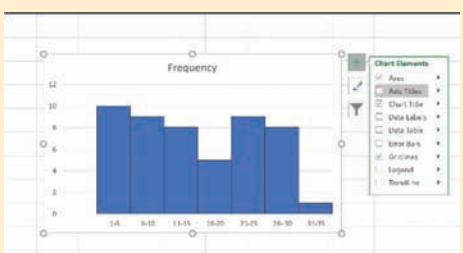
We will select the first graph.
You will now have a basic column graph.



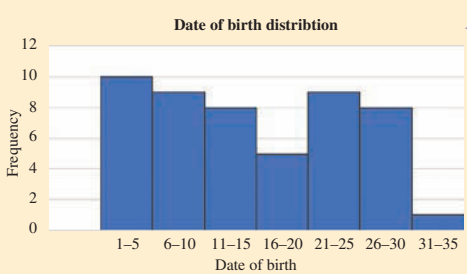
Histograms do not have gaps between columns. To fix that *right click* anywhere on one of the columns. Select 'Format Data Series' from the menu that appears.



Change the gap width to 0%.



To add axis titles, click anywhere on the graph.
Select the '+' that appears at the top right.
☑ Axis Titles



Type in your axes labels to complete the graph.

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Exercise 4C

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in the following statements.

- **a** A histogram is like a _____ graph. However, because we are using numbers we can join the columns together so there are ____ gaps.
- **b** The data scores are shown on the _____ axis.
- **c** The _____ is shown on the vertical axis.
- **d** The columns _____ each other.
- **e** There must be a _____ with the vertical axis.

Example 4

2 A group of people are asked how many times they have visited the dentist in the past year. The responses are presented below.

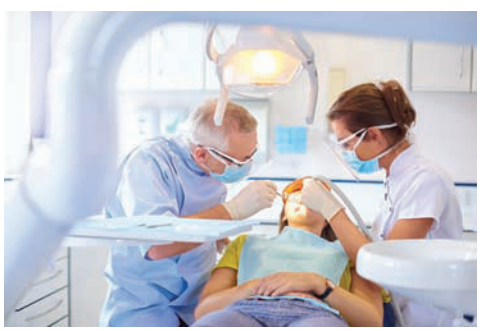
1	0	2	1	1
1	1	5	2	3
0	1	2	2	3

- **a** Organise the data according to the given frequency distribution table.
- **b** Which is the most common response?
- **c** Decide whether it best to count up in 1s, 2s or 5s to reach the highest frequency.

Hint You need 5 to 10 steps from zero to the highest frequency.

- **d** Use your answer from part **c** to present the data in a histogram.

Visits	Tally	Frequency
0		
1		
2		
3		
4		
5		
Total		



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APPLICATIONS

SF: 3–7 | CF: – | CU: –

Example 5

3 This table show the times, in minutes, it takes a group of Year 11 students to run a 5 km cross-country course.

Time (minutes)	Frequency
10–15	1
15–20	5
20–25	13
25–30	12
30–35	7
35–40	2

a How many students participated in the race?

b Identify the most common time by students to complete the race.

c Determine whether it is more suitable to count up in 1s, 2s or 5s to reach the highest frequency.

d Use your answer from part **c** to construct a histogram for the data.

Hint There are no gaps between the columns of a histogram.

★4 A group of 30 students are asked how many hours of homework and study they have done in the past week. Their responses are:

1	11	9	10	7	12	11	9	5	10
12	10	11	0	12	10	3	5	14	11
9	12	7	22	10	11	12	11	9	7

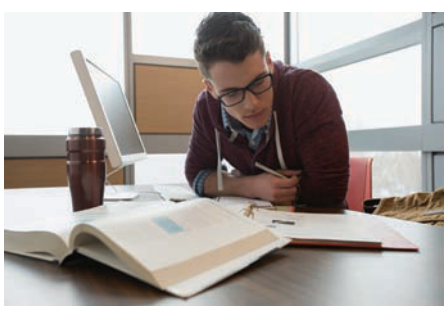
a Identify the largest amount of time spent on homework from the students surveyed.

b Decide whether it's best to count up in 1s, 2s or 5s to reach the largest amount of homework.

c Determine suitable groups for the time spent doing homework.

d Organise the data into a frequency distribution table, using groups.

e Create a histogram for the grouped data.



Hint Name the table columns 'Hours', 'Tally' and 'Frequency'.

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★5 The age of the actors at the time when they were awarded the Best Actor and Best Actress at the Academy Awards from 1988 to 2017 is listed below.

Year	Best Actress	Age (years)	Film	Best Actor	Age (years)	Film
1988	Cher	41	*Moonstruck*	Michael Douglas	43	*Wall Street*
1989	Jodie Foster	26	*The Accused*	Dustin Hoffman	51	*Rain Man*
1990	Jessica Tandy	80	*Driving Miss Daisy*	Daniel Day-Lewis	32	*My Left Foot*
1991	Kathy Bates	42	*Misery*	Jeremy Irons	42	*Reversal of Fortune*
1992	Jodie Foster	29	*The Silence of the Lambs*	Anthony Hopkins	54	*The Silence of the Lambs*
1993	Emma Thompson	33	*Howards End*	Al Pacino	52	*Scent of a Woman*
1994	Holly Hunter	36	*The Piano*	Tom Hanks	37	*Philadelphia*
1995	Jessica Lange	45	*Blue Sky*	Tom Hanks	38	*Forrest Gump*
1996	Susan Sarandon	49	*Dead Man Walking*	Nicolas Cage	32	*Leaving Las Vegas*
1997	Frances McDormand	39	*Fargo*	Geoffrey Rush	45	*Shine*
1998	Helen Hunt	34	*As Good as It Gets*	Jack Nicholson	60	*As Good as It Gets*
1999	Gwyneth Paltrow	26	*Shakespeare in Love*	Roberto Benigni	46	*Life Is Beautiful*
2000	Hilary Swank	25	*Boys Don't Cry*	Kevin Spacey	40	*American Beauty*
2001	Julia Roberts	33	*Erin Brockovich*	Russell Crowe	36	*Gladiator*
2002	Halle Berry	35	*Monster's Ball*	Denzel Washington	47	*Training Day*
2003	Nicole Kidman	35	*The Hours*	Adrien Brody	29	*The Pianist*
2004	Charlize Theron	28	*Monster*	Sean Penn	43	*Mystic River*
2005	Hilary Swank	30	*Million Dollar Baby*	Jamie Foxx	37	*Ray*
2006	Reese Witherspoon	29	*Walk the Line*	Philip Seymour Hoffman	38	*Capote*
2007	Helen Mirren	61	*The Queen*	Forest Whitaker	45	*The Last King of Scotland*

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Year	Best Actress	Age (years)	Film	Best Actor	Age (years)	Film
2008	Marion Cotillard	32	*La Vie en rose*	Daniel Day-Lewis	50	*There Will Be Blood*
2009	Kate Winslet	33	*The Reader*	Sean Penn	48	*Milk*
2010	Sandra Bullock	45	*The Blind Side*	Jeff Bridges	60	*Crazy Heart*
2011	Natalie Portman	29	*Black Swan*	Colin Firth	50	*The King's Speech*
2012	Meryl Streep	62	*The Iron Lady*	Jean Dujardin	39	*The Artist*
2013	Jennifer Lawrence	22	*Silver Linings Playbook*	Daniel Day-Lewis	55	*Lincoln*
2014	Cate Blanchett	44	*Blue Jasmine*	Matthew McConaughey	44	*Dallas Buyers Club*
2015	Julianne Moore	54	*Still Alice*	Eddie Redmayne	33	*The Theory of Everything*
2016	Brie Larson	26	*Room*	Leonardo DiCaprio	41	*The Revenant*
2017	Emma Stone	28	*La La Land*	Casey Affleck	41	*Manchester by the Sea*

a Identify the youngest and oldest Best Actress from this list and determine suitable groupings for a frequency distribution table, showing the age of the Best Actress at the time when she received her Academy Award.

b Construct a frequency distribution table for Age of Best Actress.

c Create a histogram for Age of Best Actress.

d Using the same age groupings as those used in part **b**, construct a frequency distribution table for Age of Best Actor.

e Create a histogram for Age of Best Actor.

f Comment on any similarities between the histograms.

g Comment on any differences between the histograms.

Hint Grouped numerical data vs frequency is presented using a histogram.

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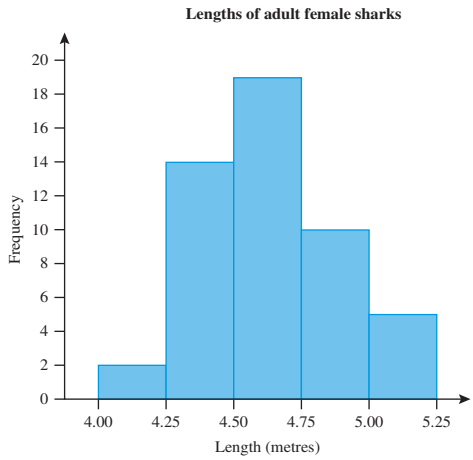
★6 Decide if each of the following datasets might produce one or more gaps when represented in a histogram. Give a reason for your decision.

a the ages of people in a Year 11 class
b the ages of people in a high school
c the ages of people in a movie theatre
d the ages of people participating in a fun run

★7 Here is a histogram that summarises the lengths of a group of sharks caught, measured and released as part of a research study.



Decide if each of the following statements is true or false according to the histogram.

a A total of five sharks were measured.
b A total of 50 sharks were measured.
c The longest shark measured was 19 m long.
d The longest shark measured was over 5 m long.
e Five of the sharks measured were over 5 m long.

Hint A histogram has no gaps between columns, so it can display continuous data.

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4D Dot plots and stem-and-leaf plots

LEARNING GOALS

- Create a dot plot to present numerical data
- Identify suitable groupings for a stem-and-leaf plot
- Create a stem-and-leaf plot to present numerical data

How are dot plots and stem-and-leaf plots essential?

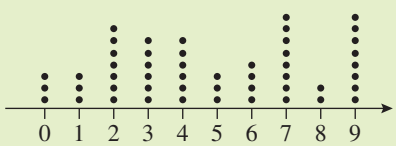
Dot plots give a quick visual representation of the distribution of data. Stem-and-leaf plots help to organise all the data into numerical order and display how it is distributed. Both these displays keep the original scores and arrange a lot of data into an ordered visual display that is much easier to follow than a list.

Many Japanese train timetables use stem-and-leaf to display 24-hour departure times. The 'stems' are hours, and each 'leaf' represents a train's departure time, in minutes past the hour.

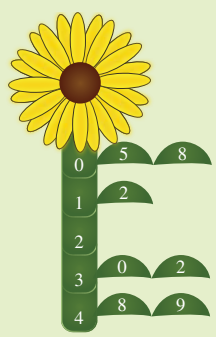
WHAT YOU NEED TO KNOW

- **Dot plots** are used for small sets of data that have a small range. Each piece of data is represented by a dot. For example:

Number of unread emails in Inbox



- A **stem-and-leaf plot** looks a bit like the stem of a plant with leaves coming off the side. It displays each data value with a stem number and a corresponding leaf number.
  - The key tells you how to interpret the stem-and-leaf parts. For example, 4|8 means 48, where 4 is the stem and 8 is the leaf.



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- The leaves data is in numerical order to allow statistical calculations to be performed easily. For example, finding a median requires the data to be in order.
- There are no commas between leaf numbers.
- The complete stem-and-leaf plot resembles a histogram with groups, but all the data is retained and shown.

The tens digits are called the *stems*.

Stem	Leaf
0	5 8
1	2
2	
3	0 2
4	8 9

The ones digits are called the *leaves*.

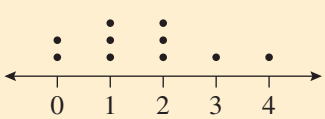
Key 4|8 = 48

Example 7 Creating a dot plot to present numerical data

A group of students are asked how many brothers and sisters they each have. The results are given below.

2 1 0 3 2 1 0 1 2 4

a How many students participated in the survey?
b Construct a dot plot for the data.
c Calculate how many brothers and sisters there are in total.

WORKING	THINKING
a 10 students participated in the survey.	There are 10 pieces of data.
b  No. of brothers and sisters	Draw a line with arrows at each end. Evenly space data labels from the lowest score to the highest score. Place a dot above the appropriate data label for each piece of data.
c Total = 2 + 1 + 0 + 3 + 2 + 1 + 0 + 1 + 2 + 4 = 16	Each piece of data represents how many siblings the student has. Add these numbers together.

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Example 8 Creating a stem-and-leaf plot to present numerical data

Below is the maximum temperature at Thargomindah Airport recorded on the first day of each month in 2017.

2017	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1st	41	43	37	28	31	18	18	22	26	19	28	40

a Organise the data into a stem-and-leaf plot.

b What was the highest temperature recorded on the first day of any month in 2017?

WORKING	THINKING
a	
Stem | Leaf 1 | 2 | 3 | 4 |	The stem will be the first part of the number (i.e. the tens digit). The smallest number is 18 and the largest number is 43, so the stem (i.e. the tens digit) will need to go from 1 to 4.
Stem | Leaf 1 | 8 8 9 2 | 8 2 6 8 3 | 7 1 4 | 1 3 0	The leaf will be the second part of the number (i.e. the units digit). Work your way through the list of data, placing the leaf of each piece of data next to the appropriate stem. Note: Since the data is not in order on each branch, it is called an **unordered** stem-and-leaf plot.
Stem | Leaf 1 | 8 8 9 2 | 2 6 8 8 3 | 1 7 4 | 0 1 3	Organise the data on each branch into numerical order. This is now an **ordered** stem-and-leaf plot. There are no commas between the leaf numbers.
Key: 4|1 means 41	Include the key.
b The highest temperature recorded was 43°C.	The last score of the bottom line will be the maximum.

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Exercise 4D

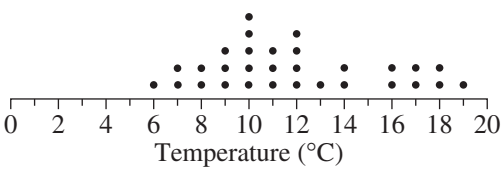
FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in the following statements.

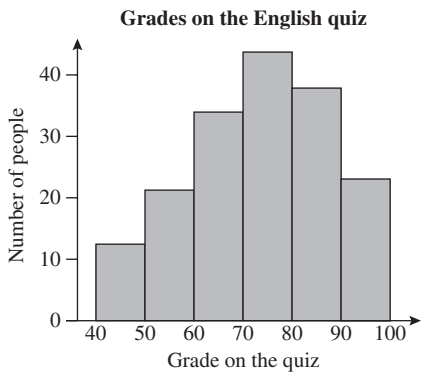
- **a** Dot _____ give a quick visual representation of the _____ of data.
- **b** Dot plots are used for small sets of ____ with a small _____. Each piece of data is represented by a _____.
- **c** Stem-and-_____ plots help to organise all the data into _____ and show how it is distributed.
- **d** A stem-and-leaf plot displays each value with a ____ number and a corresponding _____ number.

2 Match each of the following graphs (**i** to **iv**) with its correct description (**A** to **D**).

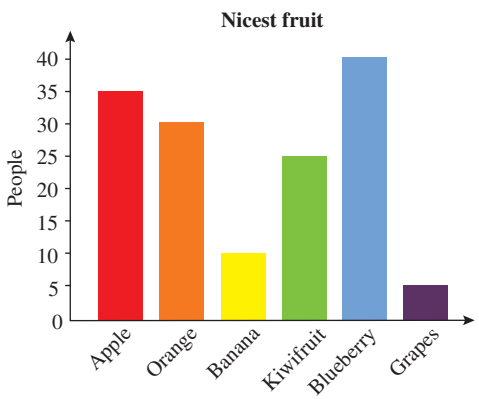
i



ii



iii



iv

Stem	Leaf
6	9
7	
8	7 8 8 9
9	0 6 7 7
10	0

Key: 6|8 means 68

- **A** column graph
- **B** stem-and-leaf plot
- **C** histogram
- **D** dot plot

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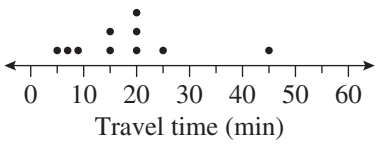
APPLICATIONS

SF: 3–8 | CF: 9 | CU: –

Example 7 ★3 A number of students are surveyed about how long it takes them to travel to school. The results are shown in this dot plot.



a How many students participated in the survey?

b Organise the data as a list of whole numbers.

c Identify the most common travel time taken.

d Identify the longest travel time taken by a student from the group surveyed.

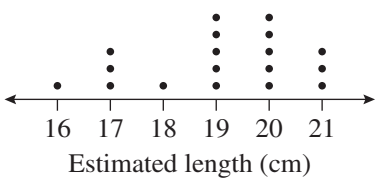
e Identify the shortest travel time taken.

★4 Shannon records the number of attempts it takes each of his 12 classmates to successfully shoot a basketball goal. Use Shannon's data (shown below) to create a dot plot.

Hint First rule a line, draw arrows and then evenly space the data labels.

1 2 1 3 1 4 4 3 1 2 5 2

★5 A teacher draws a line on a piece of paper that is 20 cm long and asks each of her students to estimate the length of the line. She uses their answers to construct the following dot plot.



a How many students are in the class?

b How many students' estimates are within 1 cm of the correct answer?

c How far off the correct answer is the least successful student's estimate?

The number of various real-time share sales in a stock market are displayed using many small LED lights as dots.

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★6 A dog breeder records how many puppies are born per litter. The past ten litters resulted in the following numbers of puppies.

4 3 4 8 3 5 5 4 4 6

a Construct a dot plot to display the numbers of puppies born per litter.
b Determine the most common litter size.
c Comment on any values of the data that appear to be unusual.

★7 The heart rates of students are taken after doing 1 minute of jumping jacks.

127, 113, 99, 84, 138, 147, 151, 121, 99, 61, 99, 86, 122, 148, 124, 114, 92, 124, 88, 129, 144

a Identify the lowest number and the highest number.
b Determine a suitable range of values to use for the stem.
c Organise the data in an ordered stem-and-leaf plot.

Hint Use tens for the stem; e.g. 148 has 14 tens.

Example 8 ★8 The maximum temperature, in °C, recorded on the first day of each month for Stanthorpe in 2017 is shown.

34 36 28 23 20 15 15 19 18 13 20 26

a Organise the data into an ordered stem-and-leaf plot.
b Determine the highest temperature recorded on the first day of any month during 2017.
c Identify the lowest daily maximum temperature recorded on the first day of the month during 2017.

Hint Create an unordered stem-and-leaf plot first.

9 Use the data from Question 5 Exercise 4C (age of actors at the time when they were awarded Best Actor and Best Actress at the Academy Awards 1988–2017), to answer the following.

a Organise the data for Best Actress into an ordered stem-and-leaf plot.
b Organise the data for Best Actor into an ordered stem-and-leaf plot.
c Compare and comment on any differences in the distribution of the data between actresses and actors.

Hint Always include a key in a stem-and-leaf plot.

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4E Outliers

LEARNING GOAL

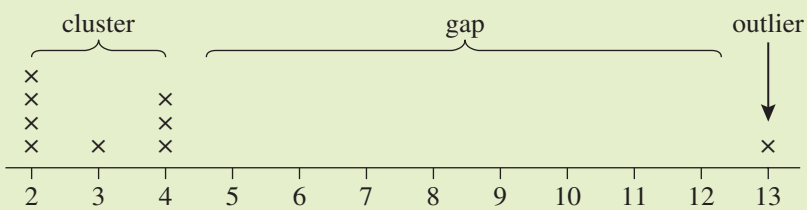
- Identify outliers in small and large datasets

Why is identifying outliers essential?

When we collect data, not all the data will have the same characteristics. Outliers can affect the calculation of the data average. Being able to identify outliers means that we can correct any abnormalities created when including them in our dataset. It could also be that the piece of data was not correctly recorded and is a mistake that we need to correct.

An **outlier** is a piece of data with a value appearing to be inconsistent with the remainder of that set of data.

WHAT YOU NEED TO KNOW



No. hours of music practice per day

- An **outlier** is a piece of data that appears to be inconsistent with the remainder of that set of data. It sits a long way above or below the rest of the data, like a student practising an instrument for 13 hours a day when the next highest result recorded was 4.

If we look at the leading top 10 Test Cricket batting averages in the table given on the next page, we can see Sir Donald Bradman's average of 99.94 sits far away from the other nine leading batsmen, who range only from 58.45 to 63.75. Therefore, Sir Don's *outstanding* batting average is an **outlier** in this set of data.

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Highest averages							
Player	**Span**	**Mat**	**Inns**	**No**	**Runs**	**Hs**	**Ave**
DG Bradman (AUS)	1928–1948	52	80	10	6996	334	99.94
SPD Smith (AUS)	2010–2018	61	111	16	6057	239	63.75
AC Voges (AUS)	2015–2016	20	31	7	1485	269*	61.87
RG Pollock (SA)	1963–1970	23	41	4	2256	274	60.97
GA Headley (WI)	1930–1954	22	40	4	2190	270*	60.83
H Sutcliffe (ENG)	1924–1935	54	84	9	4555	194	60.73
E Paynter (ENG)	1931–1968	20	31	5	1540	243	59.23
KF Barrington (ENG)	1955–1968	82	131	15	6806	256	58.67
ED Weekes (WI)	1948–1958	48	81	5	4455	207	58.61
WR Hammond (ENG)	1927–1947	85	140	16	7249	336*	58.45

Example 9 Identifying an outlier in a dataset

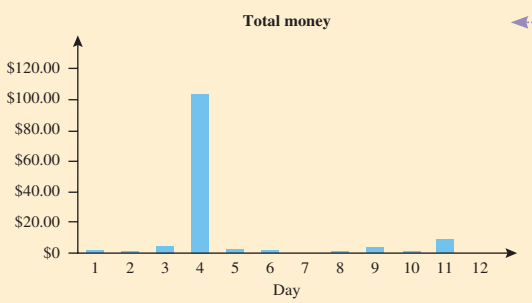
You record the amount of cash you have in your pocket each day for 12 days. The results are presented in the table.

Day	1	2	3	4	5	6	7	8	9	10	11	12
Total money ($)	1.40	0.45	4.25	101.20	2.50	1.80	0.25	0.70	3.30	1.00	9.05	0.10

a Construct a column graph showing the amount of money in your pocket over the 12 days.
b Identify any outliers within this dataset.
c Explain a likely possibility for the outlier in the data.

WORKING

a



b $101.20 is an outlier.

c If you had drawn money out from the ATM, it is possible to have more than $100 in your pocket.

THINKING

Days are marked on the horizontal axis and the amount of money is marked on the vertical axis.

The rest of the data is less than $10. This is an unusual amount.

Outliers are not always a mistake and can have a logical explanation.

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Example 10 Identifying an outlier in a large dataset

The historical monthly rainfall data recorded at Toowoomba Airport is presented below. It shows monthly total amounts of rainfall, together with calculated statistics such as mean, median, highest totals and lowest totals.

Monthly rainfall at Toowoomba Airport

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1996						0.0	39.0	57.6	48.4	49.8	71.2	104.0	
1997	37.8	229.8	22.2	1.0	59.8	9.4	9.6	2.6	74.2	132.0	128.8	102.4	809.6
1998	63.8	69.2	3.8	69.4	99.2	32.2	105.0	84.0	119.0	32.6	95.4	47.4	821.0
1999	69.1	245.6	104.6	8.0	48.6	29.8	77.8	33.6	27.0	78.6		139.0	
2000	95.8	45.4	32.6	37.8	51.6	40.8	6.4	6.2	2.0	43.8	68.4	131.0	561.8
2001	38.4	265.2	37.0	32.6	12.8	9.0	31.8	6.6	15.2	108.2	165.2	100.8	822.8
2002	14.0	60.2	159.0	10.2	9.0	54.6	0.2	67.6	22.2	16.6	68.4		
2003	9.2	145.2	86.7	59.8	28.6	62.0	14.2	19.8	4.2	94.4	23.2	118.8	666.1
2004	198.7	90.3	117.4	31.8	8.4	1.2	11.4	22.8	28.0	26.3	99.4	116.2	741.9
2005	91.6	14.2	35.4	9.4	25.6	91.6	1.4	12.4	13.0	122.8	120.4	32.4	570.2
2006	84.2	52.4	21.4	22.4	29.4	6.4	49.4	38.8	60.8	5.4	90.0	70.2	530.8
2007	26.2	56.8	5.4	17.0	13.8	55.6	0.0	55.2	34.4	67.6	63.4	62.8	458.2
2008	35.2	97.6	44.2	20.0	7.2	46.0	72.6	8.2	31.8	34.8	110.4	53.6	561.6
2009	87.6	63.4	15.2	34.4	49.4	25.2	3.8	4.2	25.6	45.0	32.0	47.6	433.4
2010	55.6	156.6	116.2	27.0	27.8	11.4	29.2	88.4	92.6	81.0	76.0	399.2	1161.0
2011	413.0	108.4	120.4	42.8	69.6	11.0	13.4	66.6	22.4	89.0	74.4	125.8	1156.8
2012	98.2	106.0	86.8	33.2	14.8	103.0	28.2	7.2	27.6	59.4	45.4	57.2	667.0
2013	416.0	184.2	113.0	41.0	51.4	61.2	27.8	4.8	16.8	43.2	80.0	39.6	1079.0
2014	12.0	12.0	190.0	7.0	35.6	25.4	13.4	30.2	18.0	12.6	54.6	251.2	662.0
2015	49.2	39.0	42.4	35.6	134.2	18.0	15.2	29.4	25.0	64.6	91.4	102.4	646.4
2016	82.2	79.6	70.2	6.4	19.0	109.6	40.4	54.8	104.0	29.0	25.0	33.8	654.0
2017	93.4	21.2	313.6	20.6	14.4	35.8	26.4	2.0	1.0	150.4	26.0	104.0	808.8
2018	8.6	189.8	51.0	23.0	7.6	13.8							

a Examine the data for June and decide if any of the data are outliers.
b Examine the data for December and decide if any of the data are outliers.

WORKING	THINKING
a No outliers	All data points lie close together, so no outliers.
b Outliers: 399.2 mm and 251.2 mm	The mean rainfall for December is 106.6 mm and all readings, except two, are less than 140 mm of rain. The readings in 2010 and 2014 were considerably higher than 106.6 mm or 140 mm, so they are outliers.

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Exercise 4E

FUNDAMENTALS

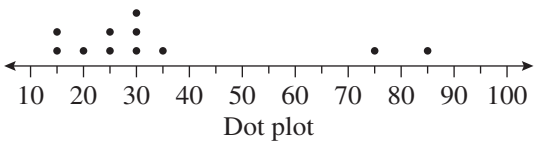
1 Demonstrate your understanding of terms by completing this sentence, selecting the words from this list.

above long outlier below

An _____ is a piece of data that appears to be inconsistent with the remainder of that set of data. It sits a _____ way _____ or _____ the rest of the data.

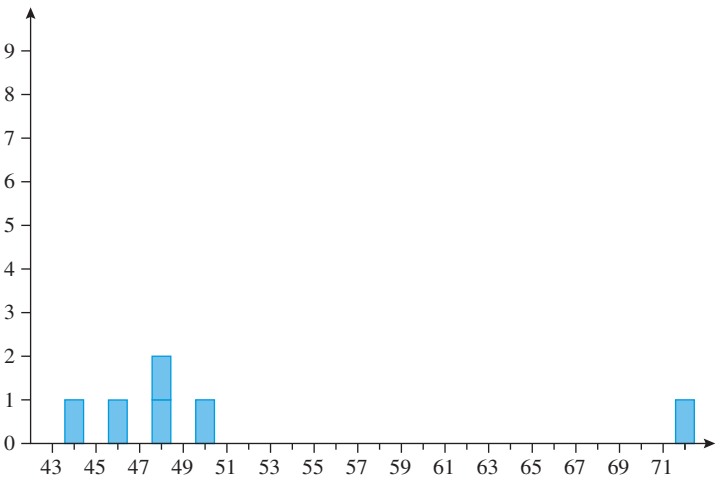
2 Identify any outliers in the following graphical displays.

a

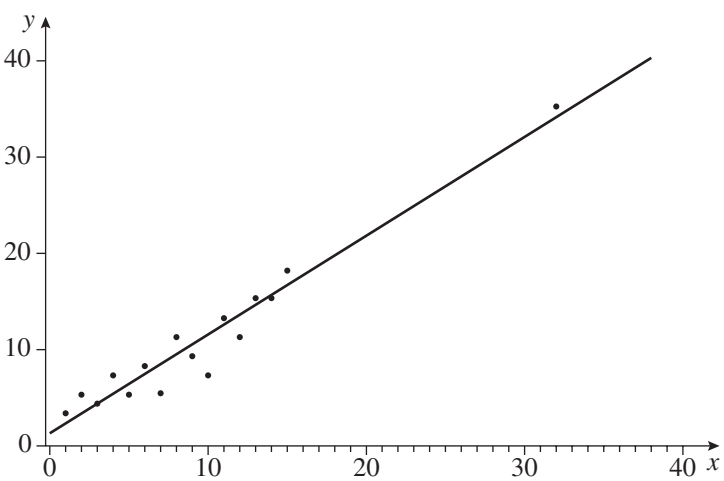


Dot plot

b



c



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APPLICATIONS

SF: 3–8 | CF: – | CU: –

Example 9 ★3 The following dataset represents the number of new computer accounts registered during ten consecutive days.

43, 37, 50, 51, 58, 105, 52, 45, 45, 10

a Reorganise the data in order from smallest to largest.
b Present the data as a dot plot.
c Identify any outliers.
d Offer a possible explanation for any unusual data in the set.

Hint An outlier is a long way above or below the rest of the data.

★4 The following data shows the distance jumped by students participating in the long jump event at an athletics carnival.

Student	A	B	C	D	E	F	G	H	I	J
Distance (m)	3.2	2.7	3.1	2.8	2.8	2.7	31	3.3	2.6	3.0

a Create a column graph to display the data.
b Identify any outliers.
c Offer a possible explanation for any unusual data in the set.

★5 The following data shows the numbers of baskets of apples picked by a backpacker over a week.

Day	Number of baskets
Sunday	14
Monday	17
Tuesday	16
Wednesday	20
Thursday	5
Friday	22
Saturday	18

a Create a column graph to display the data.
b Identify any outliers.
c Offer a possible explanation for any unusual data in the set.

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★**6** The following data represents how many fortnights the casual staff at a café worked over the past year.

10, 19, 20, 21, 22, 22, 23, 24, 24, 25, 26, 26

a Create a dot plot to organise the data.
b Identify any outliers.

Example 10

7 The table shows the medal tally for North and South American Nations at the 2016 Summer Olympic Games.

a Identify any outliers within the Total column of the table.
b Identify any outliers within the Gold, Silver and Bronze columns of the table.
c Comment on the results obtained in parts **a** and **b**.

Hint Outliers can have a logical explanation.

Nation	Gold	Silver	Bronze	Total
Argentina	3	1	0	4
Bahamas	1	0	1	2
Brazil	7	6	6	19
Canada	4	3	15	22
Colombia	3	2	3	8
Cuba	5	2	4	11
Jamaica	6	3	2	11
Mexico	0	3	2	5
Puerto Rico	1	0	0	1
United States	46	37	38	121
Venezuela	0	1	2	3

8 Referring to **Example 10**, examine the monthly rainfall data recorded at Toowoomba Airport and decide if there are any outliers for:

a January
b February
c March
d April
e May
f July
g August
h September
i October
j November

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4F Comparing how data is presented COMPLEX

LEARNING GOALS

- Analyse various presentation styles and identify whether key data is displayed or hidden
- Analyse the suitability of graphs for their purpose and compare the impressions given
- Analyse and compare various presentation styles and identify which features appeal to the intended readers

Why is comparing the presentation of data essential?

As we have seen in this chapter, there are many ways to present data and make sense of collected data, as well as make it interesting to the reader. The way in which you choose to present the information as a table or a graph will emphasise different characteristics of the data.

Presentation graphs are chosen according to which key features of the data are to be emphasised.

WHAT YOU NEED TO KNOW

- Data when collected in raw (i.e. original) form is difficult to understand. It needs to be collated in either an effective table or a graph, to allow us to make sense of it.
- A **table** is important when all information requires equal attention. It allows the reader to focus on the information that interests them, within the table.
- **Graphs** show trends in data and allow the reader to make comparisons between groups.
- Choosing a presentation method for your data that is *simple* to understand is key to communicating the message you are wanting to get across.
- We need to be careful when grouping data that we do not lose some of the key features of the data that are required to be displayed.

  The following examples show different types of tables and graphs, and the key information that is communicated and lost by each presentation style.

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Presenting the same information in different ways

In a round of golf, 20 players had the following scores over 18 holes.

68	72	74	64	68	72	66	68	71	67
68	68	71	67	69	63	68	69	73	72

In its raw form, we cannot immediately know much about this data. It would be good to easily identify what the leader scored and what most players scored. We need to organise the data.

Frequency distribution table with discrete scores

Score	Tally	Frequency
63	|	1
64	|	1
65		0
66	|	1
67	||	2
68	𝍸 ||	6
69	||	2
70		0
71	||	2
72	|||	3
73	|	1
74	|	1
Total	**20**	**20**

Some key information clearly seen

We can now see that the leader scored 63 (lowest score) and there is lots of data around 68, although the data is spread out over 12 rows.

Frequency distribution table with grouped scores

Score	Tally	Frequency
63–64	||	2
65–66	|	1
67–68	𝍸 |||	8
69–70	||	2
71–72	𝍸	5
73–74	||	2
Total	**20**	**20**

Some key information lost

If we group the data so that we have fewer rows to work with, we start to lose some detail.
It is no longer clear that 68 is the most common score; it could be 67 or 68.
We can also no longer see that the leader had the lowest score of 63; it could be a 63 or 64.

A stem-and-leaf plot grouped in 10s

Stem	Leaf
6	3 4 6 7 7 8 8 8 8 8 9 9
7	1 1 2 2 2 3 4

Some key information is not clear

This plot is not very effective at telling us how far the leader is from the rest of the field. This is because of the small number of stems.

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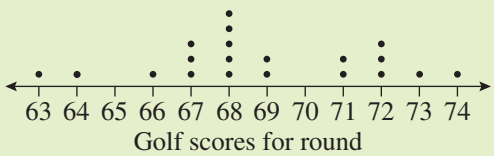
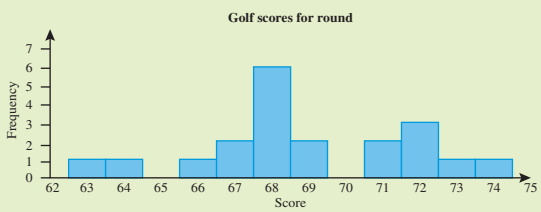
A stem-and-leaf plot grouped in 5s	Some key information not easily noticed
Stem | Leaf 6 | 3 4 6 | 6 7 7 8 8 8 8 8 9 9 7 | 1 1 2 2 2 3 4 7 |	We could make the groupings smaller on the stem by having low and high 60s, as shown. This does separate the leaders a little but the range of scores is not very clear.
Dot plot	**Original data clearly seen**
	A dot plot gives us an easy representation of how the players were distributed and how good the best players were in comparison to everyone else. We can also see that 'most' players scored around 68 for the round. Having a dot for each piece of data gives us a visual for how many players there are.
Histogram with discrete scores	**Some key information clearly seen**
	A histogram displaying **discrete** numerical data gives a visual comparison for the number of players achieving each score. We can still see the leader scored 63.
Histogram with grouped scores	**Some key information lost**
	In a histogram displaying **grouped** numerical data, the individual data is lost. For example, the graph has completely lost the leader's score of 63.

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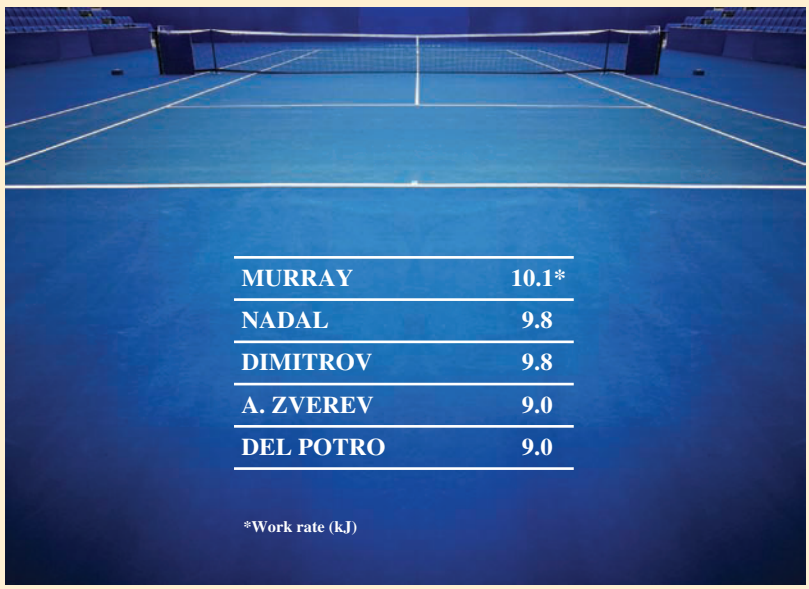
Example 11 Analysing the suitability of an infographic and a column graph for their purpose, and comparing the impressions given

The graphic below lists the amount of energy per point expended by some of the world's top tennis players.



a Create a column graph to display this data.

b Identify a possible reason why Australian Open Tennis chose to present this data in a table rather than as a column graph.

c Identify two other features of the infographic that has made Murray look like he's so much ahead of the other players.

d Decide if a table is the most suitable method for displaying this type of information. Justify your response with reasons.

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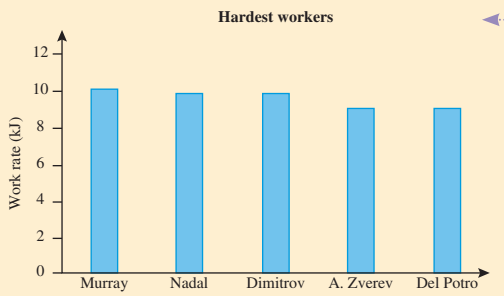
WORKING	THINKING
a 	Even though all the numbers are close together, make sure you still start at zero on the vertical axis, otherwise the difference between the players will look greater than it actually is.
b When presenting the information as a column graph, the difference between the energy used per point by the players does not appear as great as it does when the data is arranged in a table. Australian Open Tennis is wanting to emphasise that Murray uses more energy than his rivals, and a table shows that more clearly.	The difference between Murray and Nadal in energy used per point is only 0.3 kJ. To put that in perspective, a banana has 335 kJ. It will take 1116 points in a game of tennis for Murray to use more energy than Nadal. That extra energy can be gained by eating a single banana.
c By highlighting Murray's name in yellow and putting an * next to his number, Australian Open Tennis has made him stand out from the others. Also, adding his photo to the infographic has made him look better.	Visual clues make a difference.
d No, a table is not a suitable method for displaying this information. By presenting the information as a table rather than a graph, the creators of the table have tried to exaggerate the difference between the energy used by the players.	Make sure you always give a reason for your decision.

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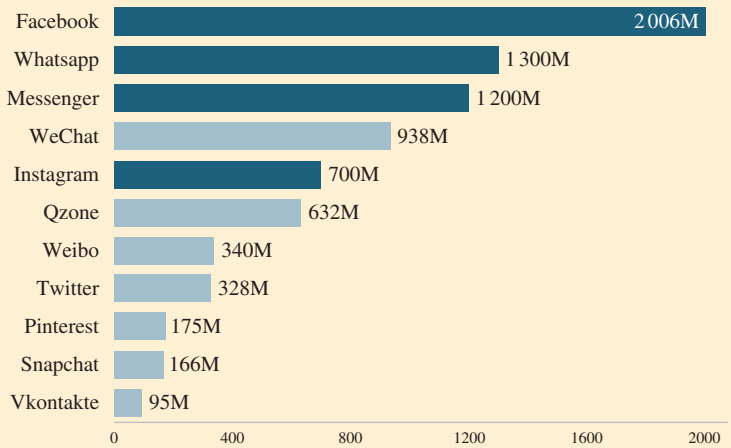
Example 12 Analysing the features of a column graph and comparing its effectiveness to a table and a dot plot

This column graph shows the worldwide number of monthly users of popular social media sites in 2017.



a Consider who this graph would be targeted at.
b Create a table to display this data.
c Explain why the producers of this graph have presented it as a column graph rather than a table.
d Identify other techniques that have been used to make the graph appealing.
e Explain whether this information could be presented in a dot plot.
f Assess whether a column graph is a suitable method for presenting this information and explain your answer.

WORKING	THINKING
a Marketing companies would use this information to help businesses connect with potential customers.	What is the purpose? Who would benefit? How would they use it?

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b

Social media platform	Monthly users (millions)
Facebook	2006
WhatsApp	1300
Messenge	1200
WeChat	938
Instagram	700
Qzone	632
Weibo	340
Twitter	328
Pinterest	175
Snapchat	166
Vkontakte	95

Note: We could almost have used billions for the units.
A billion is 1000 million or 1 000 000 000!!

c Presenting the information as a column graph is more visually appealing than a table. The differences are quickly identifiable.

Always give a reason to justify your decision.

d The producers of this graph have also used colour and images to represent the different social media platforms.

This helps the reader to quickly recognise the social media platforms being discussed.

e A dot plot would be difficult to use for this information because the numbers are so large and would require a scale; e.g. • = 200 million.

Always give a reason to justify your decision.

f A column graph is a suitable method for displaying this information. The graph is accurate, visually appealing and shows the intended information.

Always give a reason to justify your decision.

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Exercise 4F

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in the following statements.

- **a** A **table** is important when all _____ requires _____ attention.
- **b** **Graphs** show _____ in data and allow readers to make comparisons _____ groups.
- **c** Choosing a presentation method for your data that is _____ to understand is key to conveying the _____ you are wanting to get across.
- **d** We need to be _____ when grouping data that we do not _____ some of the key _____ of the data.

2 A group of Year 11 students are asked the current age of their mother. Their results are given below.

46	48	40	47	38	41	40	46	44	45
45	45	44	45	44	44	46	48	45	45

- **a** Organise the information into a frequency distribution table without grouping.
- **b** Create each of the following displays for this data.
  - **i** dot plot
  - **ii** stem-and-leaf plot
  - **iii** histogram
- **c** Decide which presentation method is best suited for the data and justify your choice.

APPLICATIONS

SF: –	CF: 3–6	CU: 7–10

Example 11 ★3 The graphic shows information about the digital activity in Australia, in January 2017.

- **a** Identify the technique that has been used to present this information.
- **b** Is it possible to have 128% of the population with mobile subscriptions? Explain how.
- **c** Construct a frequency table to display the numbers of people in each category and the total number of people. Ignore percentages.
- **d** Construct a column graph to display the numbers in each category.
- **e** Decide whether the frequency table or the column graph is the most effective way to present this information. Explain your choice.

Hint Think about the main purpose of the graphic.

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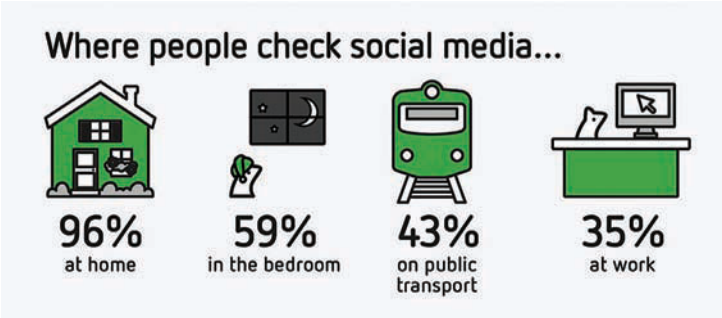
★4 The following information shows where people are when they check their social media.



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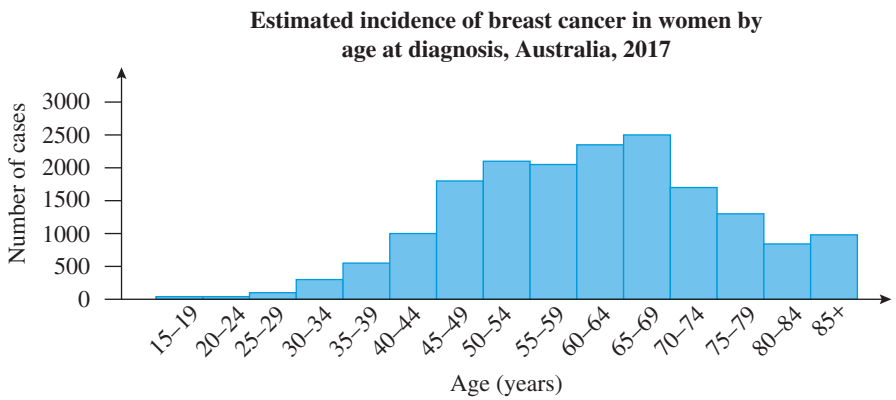
a Describe the technique that has been used to present this information.
b Construct a frequency table to display this information, with frequencies given as percentages.
c Construct a column graph to display this data.
d Could this information be presented as a dot plot? Explain why or why not.
e Decide which of the displays is the most suitable way to present this information. Explain your answer.

Example 12 ★5 The graph below shows the age of women when they were diagnosed with breast cancer.



a Describe the technique that has been used to present this information.
b Organise the information in a grouped frequency table.
c Could this information be presented as a dot plot? Explain why or why not.
d What is the most suitable way to present this information? Why?

Hint Is the data grouped or discrete?

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★6 The graph shown appeared in the *Australian Financial Review* in August 2017. It shows the price that various States and countries pay for their electricity:

a Describe the technique that has been used to present this information.

b Organise the information in a frequency table, rounding the prices to the nearest whole number.

c Could this information be presented as a dot plot? Explain why or why not.

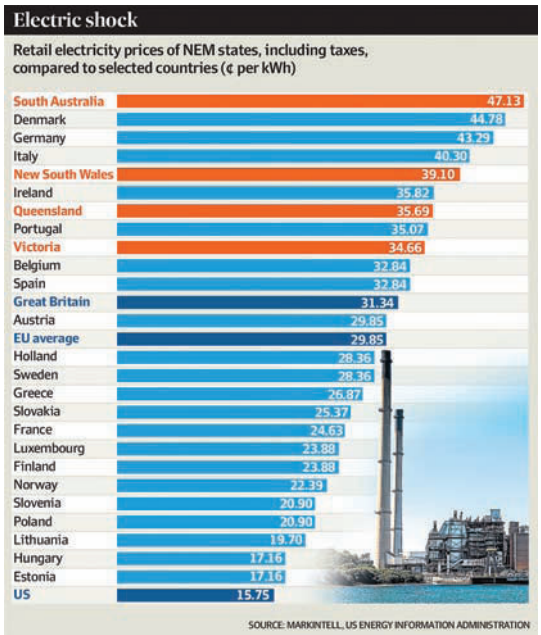
d Create a column graph, counting up in 5s on the frequency axis, to display the same data.

e Compare your column graph to the one produced in the newspaper. Identify any similarities or differences.

f Assess the suitability of the method used by the newspaper to present the information. Write sentences to summarise your assessment.

g Explain what you believe to be the most suitable way to present this information.

h The graph at right shows the share price for AGL during the same time period as the prices presented above. AGL is a major electricity, gas and solar energy provider. The graph appeared on the same web page as the story relating to the graph above of electricity prices. Explain what you think is the message that the newspaper is trying to convey about energy companies in Australia.



Australian Financial Review, 4 August 2017

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★7 The following table shows key trends associated with methamphetamine use between the periods 2009–10 and 2013–14.

Selected key trends in methamphetamine use, availability and treatment, 2009–10 to 2013–14

	2009–10	2013–14
Arrests	14 000	26 300
Seizures	10 500	26 800
Detections	700	2400
Recent users reporting lifetime crystal use	190 000	280 000
Treatment episodes	10 000	28 900

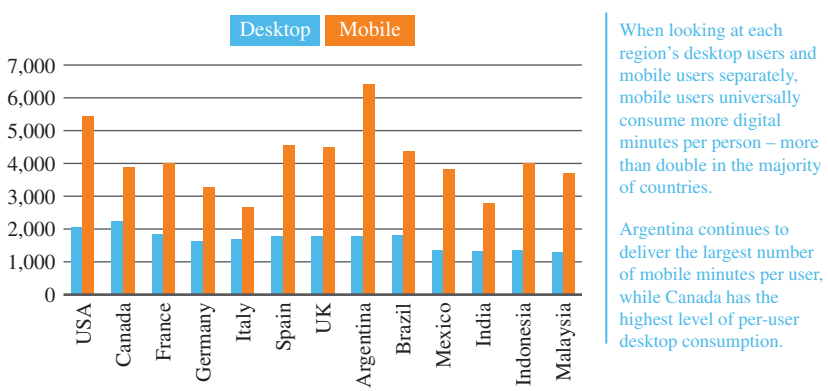
a Describe the technique that has been used to present this information.
b Explain why you think the information has been presented in this way.
c Construct a column graph with two columns for the respective time frames.
d Discuss if there are any other ways this information could be presented.
e Explain which is the most suitable way of presenting this information.

★8 The following graph shows time spent, in minutes per user, on either desktop or mobile devices.

a Describe the technique that has been used to present this information.
b Explain why you think the information was presented in this way.
c Construct a table to display this information.
d Could this information be presented as a dot plot? Explain why or why not.
e Explain what you believe to be the most suitable way to present this information.

Mobile users consume more than 2x minutes vs. desktop users

Average Minutes per User by Platform



Source: www.smartinsights.com/mobile-marketing/mobile-marketing-analytics/mobile-marketing-statistics/

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★**9** The following graph shows how people from across the world access the internet.

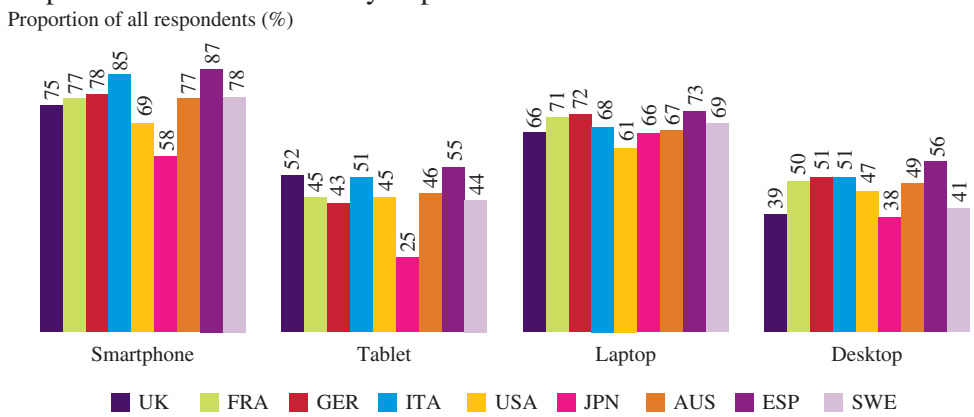
a Describe the technique that has been used to present this information.

b Give a possible explanation for why the information has been presented in this way.

c Organise the information into a table.

d Discuss if there are any other ways this information could be presented.

e Explain the most suitable way to present this information.


Proportion of all respondents (%)
75 77 78 85 69 58 77 87 78
52 45 43 51 45 25 46 55 44
66 71 72 68 61 66 67 73 69
39 50 51 51 47 38 49 56 41
Smartphone
Tablet
Laptop
Desktop
UK FRA GER ITA USA JPN AUS ESP SWE

Source: www.smartinsights.com/mobile-marketing/mobile-marketing-analytics/mobile-marketing-statistics/

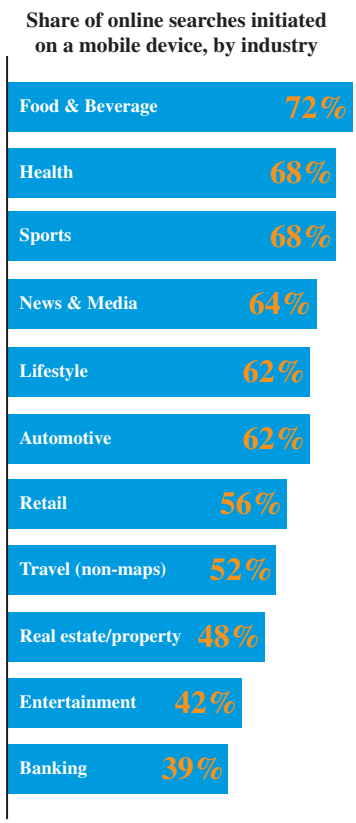
★**10** The following graph shows how consumers research products using their mobile device.

a Describe the technique that has been used to present this information.

b Give a possible explanation for why the information has been presented in this way.

c Discuss if there are any other ways this information could be presented.

d Explain the most suitable way to present this information.


Share of online searches initiated on a mobile device, by industry
Food & Beverage 72%
Health 68%
Sports 68%
News & Media 64%
Lifestyle 62%
Automotive 62%
Retail 56%
Travel (non-maps) 52%
Real estate/property 48%
Entertainment 42%
Banking 39%
Based on top search variations resulting in a click to the indicated industry, April 10 - May 7, 2016.

Source: www.smartinsights.com/mobile-marketing/mobile-marketing-analytics/mobile-marketing-statistics/

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Problem-solving and modelling task

Background: Interpreting and presenting data are key skills in all aspects of life but especially in education, business, management, and media and communications. Two stimulus items are presented here as the basis of this task.

STIMULUS 1

The following article appeared in *The Courier-Mail*, 10 January 2018.

Southerners adding tough competition to find job in Queensland
JOHN McCARTHY, The Courier-Mail

INTERSTATE interlopers are adding to tough competition to find a job in Queensland, as the typical wait to find a job in the Sunshine State stretches to six months, the worst of all states.

Australian Bureau of Statistics data shows that, despite nation-leading jobs growth, the search for a job is the longest in Queensland at 26 weeks. Brisbane is 24 weeks.

In NSW, it takes a mere 13 weeks and Victoria 12 weeks. For the long-term unemployed, the wait in Queensland for a job could be as high as 126 weeks, or almost $2\frac{1}{2}$ years, compared with the national median of 106 weeks.

Some areas of Queensland are better than others for finding work.

The coal town of Mackay is one. It takes a mere five weeks to land a job there, but in Toowoomba the median time is 64 weeks and Wide Bay is 61 weeks.

The time it takes varies widely throughout the year, but the delays in Queensland have been occurring since June last year when the wait time suddenly spiked in the unadjusted data.

"The interstate migration would be a sensible explanation," QEAS economist Nick Behrens said. That's backed up by ABS data that shows Queensland recorded the highest quarterly increase in interstate migration since 2007 at 5038 people last year.

For the June year, Queensland had the highest net gain with 17,400 people.

Mr Behrens said that a good measure of the labour market was how long it took to get a job and the data showed that Queensland had a long way to go despite having *strong jobs growth*.

He said another explanation could be that people who had not been in the market for a job, such as students or people doing home duties, have been lured back because of the *strong growth in jobs*.

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Job wait times

Brisbane: 24 weeks
Ipswich: 40 weeks
Logan: 16 weeks
Moreton Bay North: 47 weeks
Cairns: 22 weeks
Maranoa: 22 weeks
Fitzroy: 47 weeks
Gold Coast: 14 weeks
Mackay: 5 weeks
Outback: 45 weeks
Sunshine Coast: 14 weeks
Toowoomba: 64 weeks
Townsville: 37 weeks
Wide Bay: 61 weeks

STIMULUS 2

A snapshot of employment by industry in 2016, in Mackay and across Queensland revealed the following information.

Employment by industry, Mackay (R) LGA and Queensland, 2016

Industry	Mackay (R) LGA		Queensland		Specialisation ratio
	Number	%	Number	%	Number
Agriculture, forestry and fishing	1844	3.5	60608	2.8	1.23
Mining	6516	12.4	49997	2.3	5.28
Manufacturing	3425	6.5	128787	6.0	1.08
Electricity, gas, water and waste services	516	1.0	23883	1.1	0.88
Construction	3922	7.4	191338	9.0	0.83
Wholesale trade	1969	3.7	56370	2.6	1.42
Retail trade	5252	10.0	211778	9.9	1.00
Accommodation and food services	3297	6.3	156670	7.3	0.85
Transport, postal and warehousing	3343	6.3	108083	5.1	1.25
Information media and telecommunications	289	0.5	25265	1.2	0.46
Financial and insurance services	701	1.3	54286	2.5	0.52
Rental, hiring and real estate services	863	1.6	42500	2.0	0.82

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Industry	Mackay (R) LGA		Queensland		Specialisation ratio
	Number	%	Number	%	Number
Professional, scientific and technical services	2161	4.1	133652	6.3	0.66
Administrative and support services	1532	2.9	75336	3.5	0.82
Public administration and safety	2318	4.4	140164	6.6	0.67
Education and training	3933	7.5	192143	9.0	0.83
Health care and social assistance	5647	10.7	276945	13.0	0.83
Arts and recreation services	406	0.8	33667	1.6	0.49
Other services	2604	4.9	83470	3.9	1.26
Total[(a)]	**52732**	**100.0**	**2136455**	**100.0**	**1.00**

Source: ABS, *Census of Population and Housing, 2016, General Community Profile – G51* and unpublished data.

Some key points of interest have been highlighted in italic in the newspaper article.
Task: Your task is to write a follow-up article that includes graphs and is encouraging to prospective workers moving to Queensland on the promise of 'strong jobs growth'.

Some things to include:

- The regions in Queensland that have the lowest job wait times.
- The industries that have the highest workforce in those regions.

To complete this task, follow the problem-solving workflow diagram on the following page and use the steps listed as a guide.

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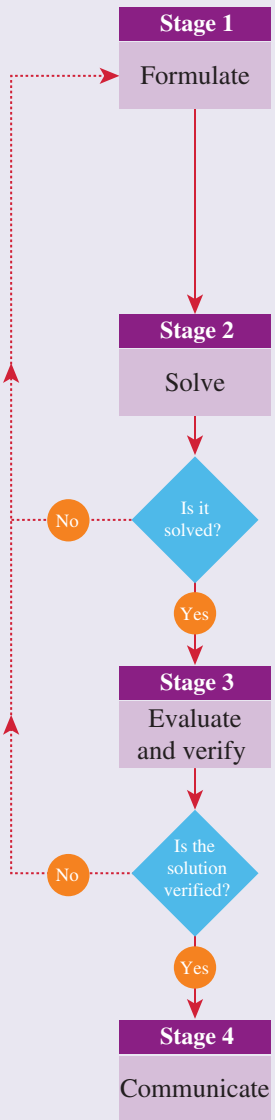

Stage 1: Formulate

1 Identify any information available.
2 Decide upon the technology that you will use to produce your graphs.

Stage 2: Solve

3 Identify regions in Queensland with the lowest job wait times.
4 Identify industries with the highest workforce in those regions.
5 Use technology to create graphs to support your reasons for people to move to Queensland for work.

Stage 3: Evaluate and verify

Once you have developed your graphs, consider:
6 How reasonable are they?
7 Have you presented them in the most suitable way?
8 Will they be appealing to prospective people considering moving to Queensland?

Stage 4: Communicate

Write a report with an introduction, body and conclusion.
9 Communicate your main point of the article.
10 Include the evidence in the form of statements, graphs and tables of regions and industries that have good employment prospects for people moving to Queensland.
11 Explain the evidence. Use a sentence starter like 'This means…'.
12 In the conclusion, link back to your main point.

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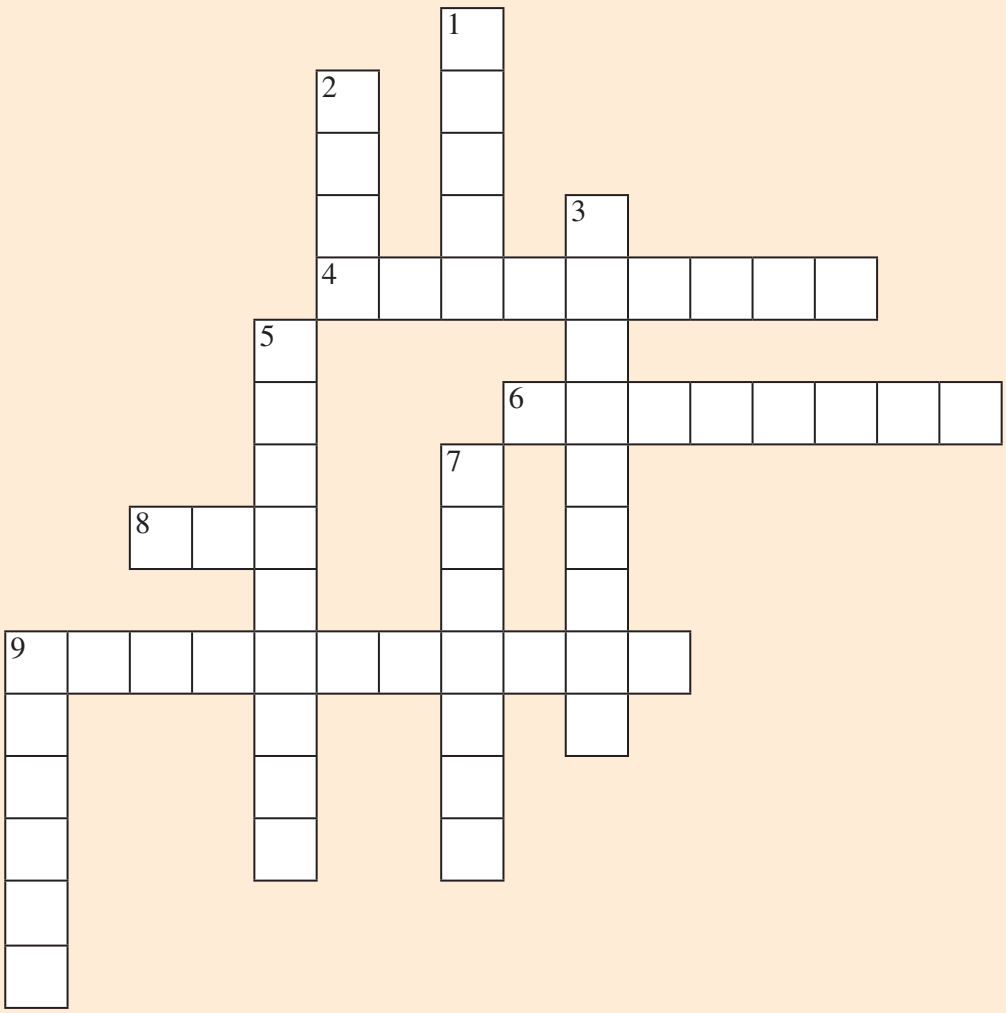
Puzzle



Across

4 How many times data occurs
6 Frequency is shown on the ____ axes on a column graph.
8 A graph that is made up of points in columns is called a ____ plot.
9 Data that can be categorised into groups (words)

Down

1 A graph should always have a ___ explaining what it displays.
2 Stem and ___
3 Data that consists of numbers
5 A ___ is like a column graph but is for numerical data and has no gaps.
7 Highest score
9 A ____ graph is used to represent categorical data.

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Chapter checklist

☐ I understand the difference between categorical and numerical data.

For each of the following, choose from either categorical or numerical.

1 **a** Data collected on the number of people attending the home games for a football team would be _____ data.

b Data collected on the favourite football team of people attending a football game would be _____ data.

☐ I understand how to display categorical data in frequency tables and column graphs.

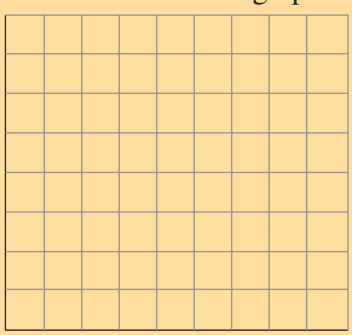
2 The main sport played by a group of students is given below.

netball	rugby league	cricket	rugby league	netball
rugby league	cricket	netball	netball	cricket
cricket	netball	rugby league	netball	netball
cricket	netball	cricket	rugby league	hockey

a Organise the data into a frequency table.

Sport	Tally	Frequency
Netball		
Rugby league		
Cricket		
Hockey		
Total		

b Construct a column graph displaying the data.



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☐ I understand how to display numerical data as a frequency distribution table, dot plot, stem-and-leaf plot and a histogram.

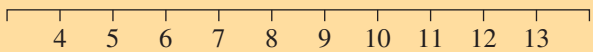
3 The amount of time (in hours) a group of students spend preparing for a test is presented below.

6	11	5	6	7	5	10	6	9	5
5	5	4	12	6	8	5	6	5	6
7	6	6	7	5	6	9	5	6	4

a Organise this information into a frequency distribution table.

Hours of study	Tally	Frequency
4		
5		
6		
7		
8		
9		
10		
11		
12		
Total		

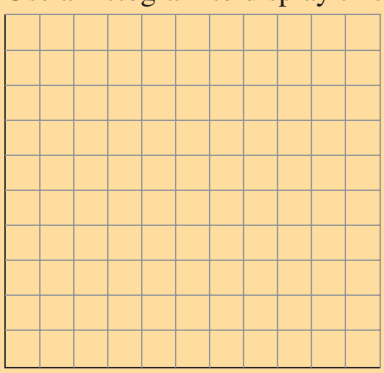
b Construct a dot plot to display this information.



c Construct a stem-and-leaf plot to display this information.

Stem	Leaf
0	
1	

d Use a histogram to display this information.



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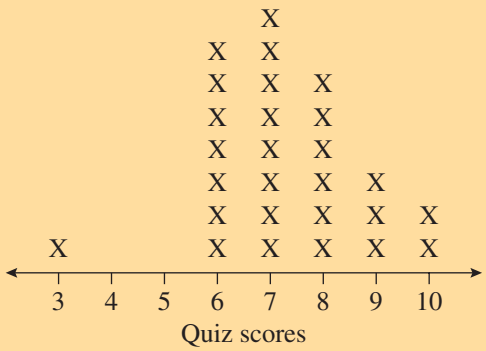
I can recognise and identify outliers from a dataset.

4 Identify any outliers in this dataset.



I can compare the suitability of different methods of data presentation in real-world contexts.

Peas in pod	Frequency
3	5
4	10
5	28
6	36

5 **a** Decide whether the information about the number of peas in a pod could be presented as a:
- **i** dot plot
- **ii** stem-and-leaf plot
- **iii** column graph
- **iv** histogram

b Explain why each method could/could not be constructed for this data.

c Decide which would be the most suitable way to present the information in a graph.

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Chapter review

All questions in the Chapter Review are assessment-style.

Simple Familiar

1 Classify each type of data as categorical or numerical. Give two possible responses to each question.

- **a** How many pets do you own?
- **b** What type of pet do you have?
- **c** What stock shares do you own?
- **d** How many stock shares do you own?
- **e** Price paid for fuel
- **f** Type of fuel your car uses

2 You are asked by the Student Representative Council to survey students about the school canteen.

- **a** Design two questions that collect numerical data.
- **b** Design two questions that collect categorical data.

3 The students of a Year 11 home room class are surveyed about which maths subject they are studying. Their responses are:

Essential	Methods	General	Essential	Methods
Methods	Essential	General	Methods	General
General	General	Essential	General	General
General	Essential	Methods	Methods	Methods & Specialist
Methods & Specialist	General	Methods & Specialist	Methods	Essential

- **a** Organise the information into a frequency table.
- **b** Identify the subject with the highest frequency.
- **c** Determine how many steps it would take to reach the highest frequency:
  - **i** if we count up in 1s
  - **ii** if we count up in 2s
  - **iii** if we count up in 5s
- **d** Decide upon the most suitable scale to count with to reach the highest frequency.
- **e** Construct a column graph to represent this data.

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4 The ages of the 50 employees at a fast-food restaurant are listed below.

18	19	19	25	20	21	18	22	18	19
25	18	21	24	25	22	18	23	24	19
18	21	23	20	24	23	19	21	23	20
20	21	22	24	23	25	21	20	22	20
19	19	18	21	21	19	24	21	21	21

a Organise the data into a frequency distribution table.
b Construct a dot plot to display this data.
c Organise the data into a stem-and-leaf plot.
d Construct a histogram for this data.
e Explain which graph is the most suitable way to present this information.

5 Identify any outliers in the following sets of data. Account for any unusual data if possible.

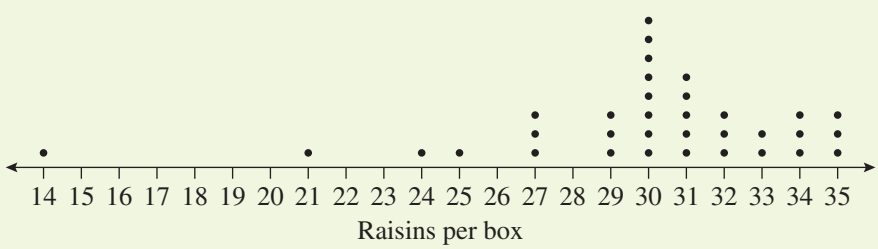
a

47	48	69	79	65	66	4	78	91
53	68	89	67	92	77	76	90	73

b

Stem	Leaf
0	3
1	
2	
3	2 5 5 7 8 9
4	0 2 3 6
5	4 7
6	5
7	
8	
9	
10	
11	5
12	6

c



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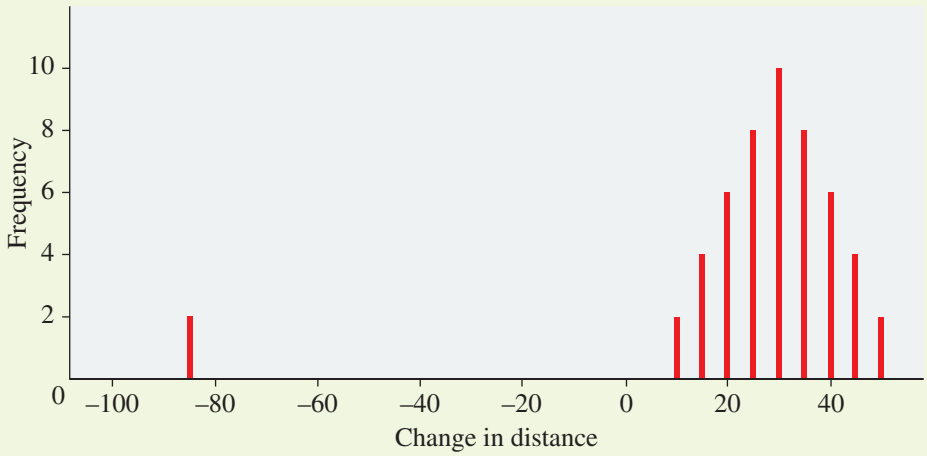
d



Questions **6** and **7** use the following information about nutritional breakdown and major nutrient of common foods.

Nutritional breakdown of selected foods by calories and major nutrient

	Calories per serving size	Major nutrient
Proteins		
chicken breast	280	niacin
round steak	300	vit. B12
T-bone steak	412	vit. B12
lobster	160	vit B12
shrimp	66	vit. B12
sirloin steak	260	vit. B12
turkey	230	niacin
salmon	300	vit. B12
pork	420	vit. B1
spinach	21	vit. A
swordfish	270	niacin
tuna	270	niacin

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	Calories per serving size	Major nutrient
Carbohydrates		
tomato	32	vit. C
potato	300	vit. C
sweet potato	82	vit. A
cucumber	8	potassium
pumpkin	41	vit. A
beans (black)	136	potassium
beans (kidney)	109	potassium
corn	69	vit. B6
pasta	320	vit. B1
whole-wheat bread	67	magnesium
brown rice	116	vit. B6
apple	160	vit. C
orange	65	vit. C
Vegetables		
celery	14	potassium
broccoli	20	vit. C
onion	30	potassium
green peppers	12	vit. C
cabbage	16	vit. K
carrots	26	vit. A
peas	57	vit. C
lettuce	10	vit. A
cauliflower	14	vit. C
mushrooms	45	niacin
asparagus	24	vit. C

Note: Serving size $= \frac{1}{2}$ cup, or 8 oz or 227 grams.

Source: https://labwrite.ncsu.edu/res/gh/gh-tables.html

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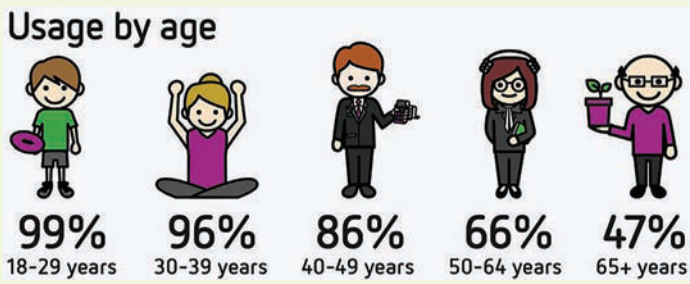
6 Refer to the data for calories per serve.

- **a** Determine if this data is categorical or numerical.
- **b** Identify the lowest and highest calorific foods.
- **c** Determine a suitable grouping for the calories and organise the data into a grouped frequency distribution table.
- **d** Construct a histogram to display this data.

7 Refer to the major nutrients in common foods.

- **a** Determine if this data is categorical or numerical.
- **b** Organise the information into a frequency table.
- **c** Construct a column graph to display this data.

8 The following information shows the usage of social media by age.



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- **a** Describe the technique that has been used to present this information.
- **b** Explain why you think the information has been presented in this way.
- **c** Construct a column graph to display this information.
- **d** Could this information be presented as a dot plot? Explain why or why not.
- **e** Explain what you believe to be the most suitable way to present this information.

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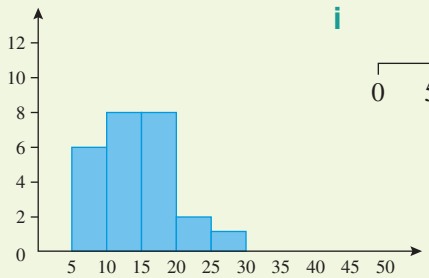
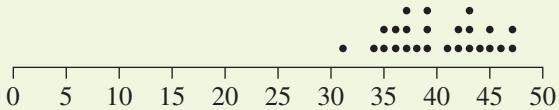
Complex Familiar

9 Five sets of data have been displayed as both a histogram (**A** to **E**) and a dot plot (**i** to **v**), as shown below.

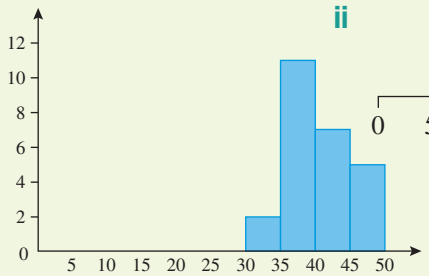
A



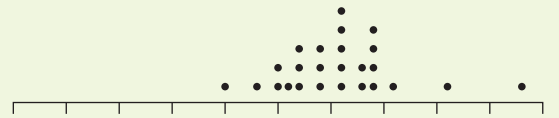
i



B



ii



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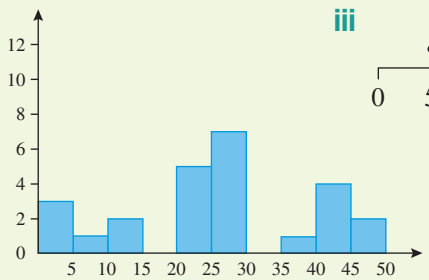

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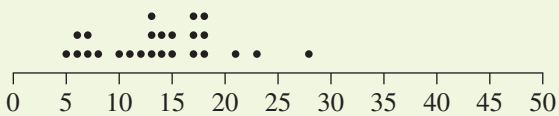

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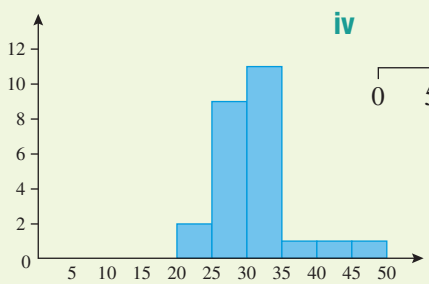

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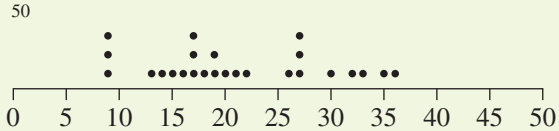

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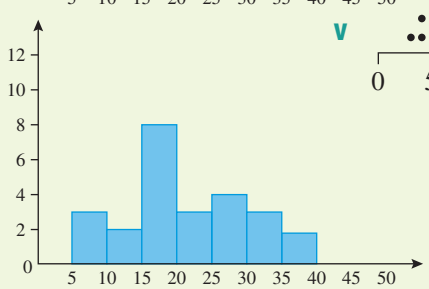

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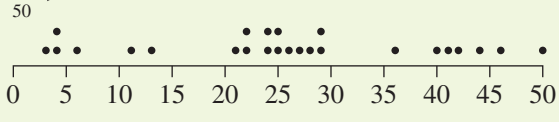

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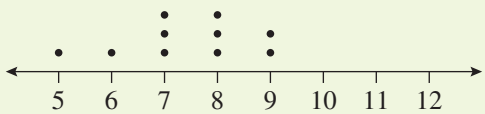
a Determine which dot plot shows the same data as histogram A.
b Determine which dot plot shows the same data as histogram B.
c Determine which dot plot shows the same data as histogram C.
d Determine which dot plot shows the same data as histogram D.
e Determine which dot plot shows the same data as histogram E.

Complex Unfamiliar

10 Three sets of data about ten Year 6 students were used to create three dot plots.
The person who created these dot plots forgot to label them.
For each dot plot identify the appropriate label from options **i**, **ii** and **iii**.

i Age (in years)
ii Numbers of hours of sleep on nights before school days
iii Numbers of hours of sleep on nights before non-school days

A



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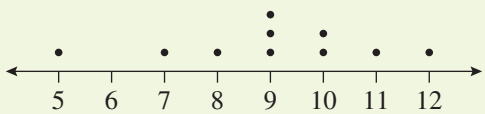

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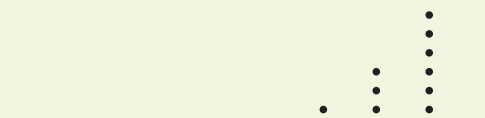

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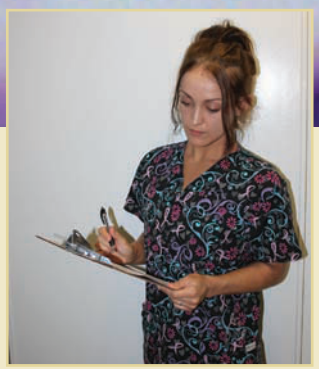
5 Reading and interpreting graphs



Maths for a Registered Nurse: Sigrid Burton

Tell us a bit about your job. What does a typical day look like?

I am currently working in a Cancer Care Unit, where I monitor my patients' side effects and blood results, throughout their treatment.

What maths did you study at school?

I never really enjoyed maths at school, and never thought I would ever be capable of using maths in a career.

How do you use maths in your job? Could you give some examples?

In my job I now use mathematics in a variety of ways. I regularly need to be able to read, analyse and interpret data. Drug calculations are required before administration, and each patient's treatment requires nurses to interpret pathology results. In my daily rounds I am continually recording, reading and interpreting patients' vital signs such as temperature, pulse and blood pressure. I also use fractions and ratios, rates, conversion of units and determine an amount as a percentage of another. I also use dot plots, comparing data, line graphs and two-way tables, and use, interpret and draw graphs.

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In this chapter

5A Step graphs and column graphs
5B Pie graphs and picture graphs
5C Line graphs and conversion graphs
5D Two-way tables
5E Misleading graphs and tables **[complex]**
5F Interpreting tables and graphs **[complex]**
Problem-solving and modelling task
Puzzle
Chapter Checklist
Chapter Review

Syllabus reference

Unit 1 Topic 3 Reading and Interpreting Graphs (8 hours)

In this subtopic, students will:

- interpret information presented in graphs such as step graphs, column graphs, pie graphs, picture graphs, conversion graphs of calories ↔ kilojoules; and interpret information in line graphs using units of energy to describe consumption of electricity, including kilowatt hours
- interpret information presented in two-way tables
- discuss and interpret tables and graphs, including misleading graphs found in the media and in factual texts **[complex]**.

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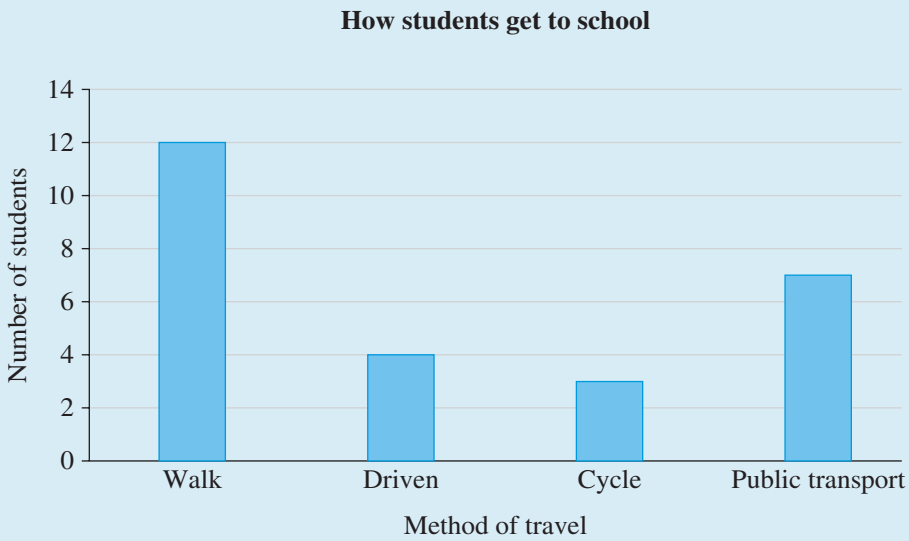
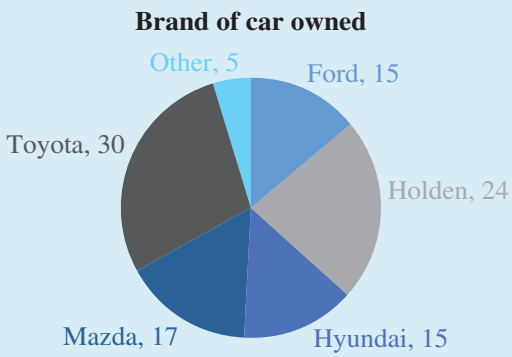
Pre-test

1 A class of 26 students are asked how they usually get to school. The results are shown in the following graph.



a How many students are driven to school?
b How many students cycle to school?
c What is the most common method of getting to school for this class of students?

2 A group of 106 young adults are asked what brand of car they own. The results are shown in the following pie chart.



a How many young adults own a Mazda?
b What brand is the most common?
c What is the difference between the number of people who own a Hyundai and the number of people who own a Holden?

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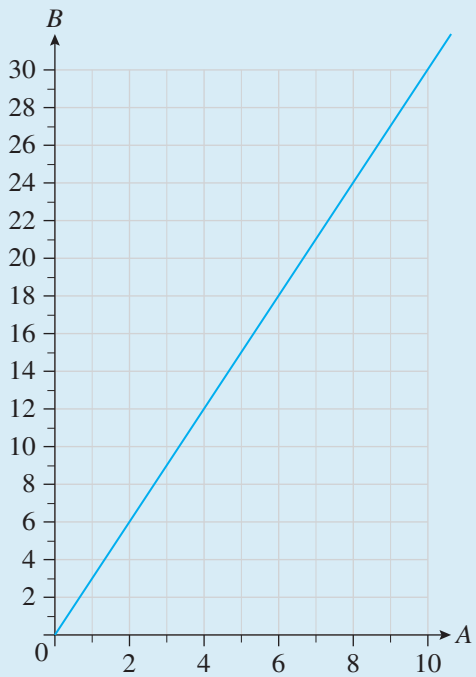
3 The graph below shows the relationship between two units, A and B.



a What is the value of B when A is 2?
b What is the value of B when A is 7?
c What is the value of A when B is 12?
d What is the value of A when B is 27?

4 Construct a two-way table from this data of the number of boys and girls in two different classes. Don't forget to include totals for each row and column of the table.

- There are 16 boys and 10 girls in Class B.
- There are 13 girls and 12 boys in Class A.

A link to a HOTmaths lesson is provided in the Interactive Textbook to revise this topic.

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5A Step graphs and column graphs

LEARNING GOALS

- Read and interpret information presented in step graphs
- Read and interpret information presented in column graphs

Why are step and column graphs essential?

Every day we are bombarded by data and information. It is much simpler to understand groups of data when it is expressed in the form of a graph. Graphs are used in our everyday life; step graphs are used to determine how much parking we must pay and how much postage to pay; and your electricity bill comes with column graphs, comparing usage from the same time last year. It is therefore essential that you learn how to read and interpret these graphs.

Column graphs are often used in the media during an election to better present the required information to the viewers.

WHAT YOU NEED TO KNOW

- A **step graph** is a type of line graph that looks like steps and consists of a series of horizontal line segments with vertical gaps from one segment to the next.
- A closed circle on a line segment represents an included value.
- An open circle on a line segment represents an excluded value.
- **Column graphs** display the quantity of data in various categories. When the columns are horizontal it is usually called a **bar graph**.
- The categories are labelled at the base of the columns.
- Categories are mostly given word names, but some categories are **integers**.
  - For example: Labels for hotel star ratings are the integers 5, 4, 3, 2 and 1.

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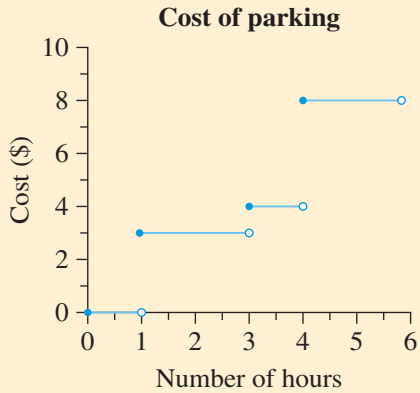
Example 1 Reading and interpreting information from a step graph

Lilly parks her car at a shopping centre. The parking costs are shown in the following step graph.

a Determine how much will it cost Lilly to park for 2 hours.

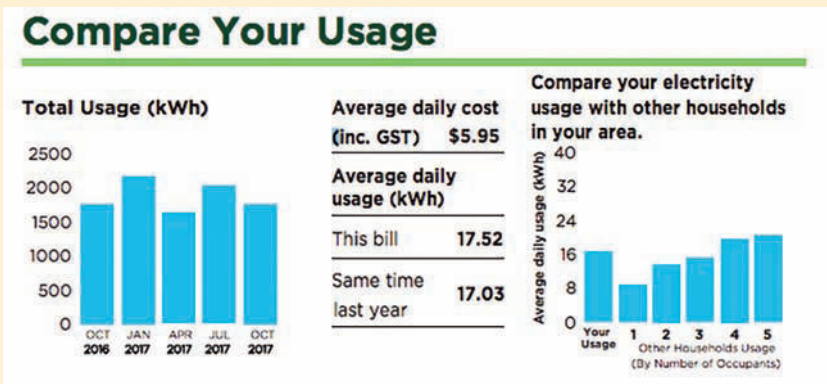
b Lilly runs into a friend and they have a coffee. She has now parked for a total of 4 hours. Calculate how much extra Lilly must pay for parking.



WORKING	THINKING
a $3	Go from 2 hours up to the line and read off the vertical scale.
b $5 extra	The cost for 4 hours is $8 because at 4 hours you must go up to the closed circle. So the difference is $8 - 3 = 5$.

Example 2 Applying information from practical graphs to real-life situations

Shown below are column graphs from the Heart family's electricity bill. The Heart's household comprises three family members.



a Identify the quarter in which the Heart family has used the most energy.

b Give some reasons why the Heart family might have used the most energy in these months.

c Explain how the Heart's average daily usage compares with other households in their area.

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WORKING	THINKING
a The quarter starting at January has the most energy usage.	Determine the highest columns on the 'Total Usage' column graph.
b January to March • They used more air conditioners. • They used more fans. • More family members at home during the holidays using electrical appliances.	January is a hot month.
c The Heart family uses more energy than the average one- to three-person household in their area, but less energy than the average four- or five-person household.	Read the comparison graph on the right and compare the column heights. The Heart family uses, on average, about 1 kWh per day more energy than the average three-person household in their area.

Exercise 5A

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in the following statements.

Hint Use WYNTK and the examples as a guide.

a A step graph consists of a series of _____ line segments.

b A step graph is a type of _____ graph.

c A line segment on a step graph with a closed circle indicates an _____ value.

d A line segment on a step graph with an open circle indicates an _____ value.

e Column graphs display the quantity of data in various _____.

f When the columns are horizontal it is usually called a _____ graph.

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Example 1

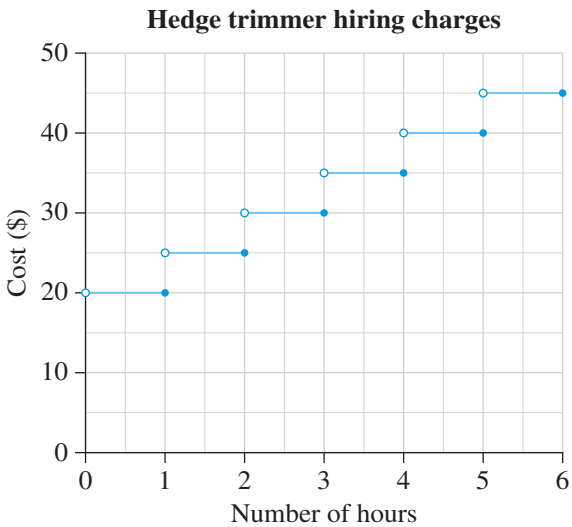
2 A hedge trimmer can be hired for a fee of $15 plus a charge of $5 per hour or part thereof, as seen in the following graph.

a Determine the cost of hiring the hedge trimmer for:

i 1 h **ii** 4 h 10 min **iii** $2\frac{1}{2}$ h

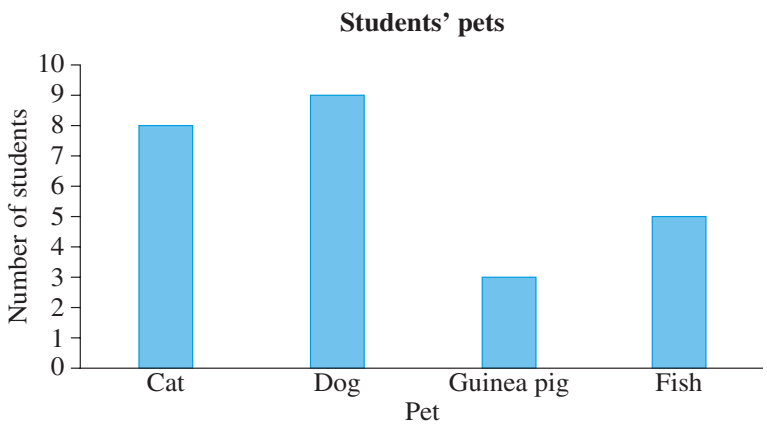
b Why would there be an initial charge of $20?

Hint A *closed* circle on a line segment represents an *included* value. An *open* circle on a line segment represents an *excluded* value.



Example 2

3 A group of students who own pets are asked what type of pet they have. The results are shown in the column graph.



a Determine how many students said they owned a cat.

b Determine how many students said they owned a fish.

c Identify the most popular response.

d Identify the least popular response.

Hint Find 'Cat' along the horizontal axis, go up the column, then go across to find the 'Number of students' in the vertical axis.

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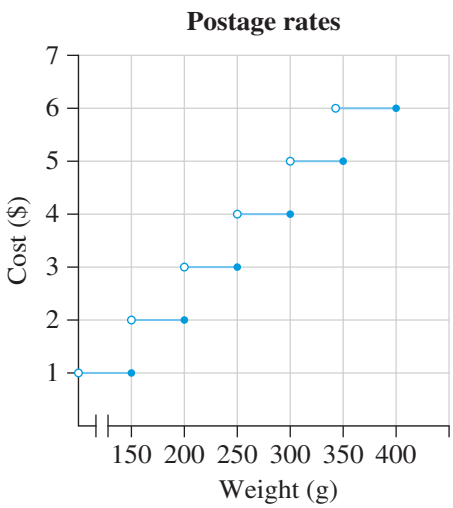
APPLICATIONS

SF: 4–9 | CF: – | CU: –

★4 Don wishes to mail a package to his friend, who is currently overseas. The cost of sending a package depends on its weight. These costs are given in the step graph.

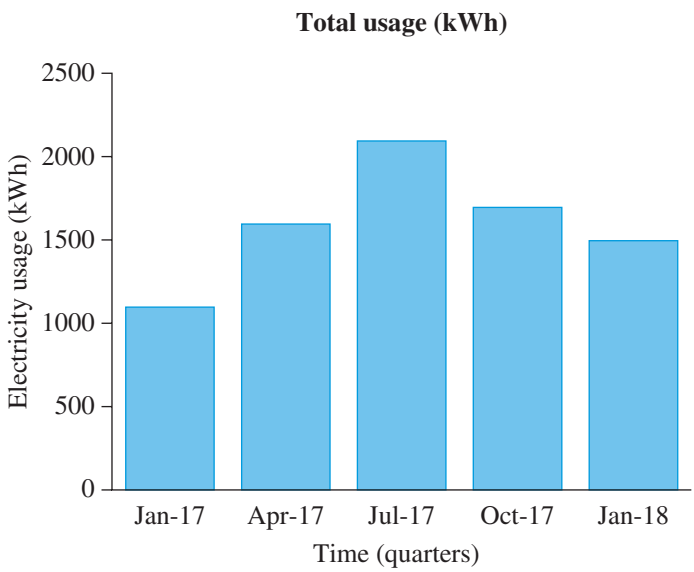


a The parcel weighs 395 grams. How much will it cost to post?

> Hint Find the weight along the horizontal axis, go up to the step, then go across to the vertical axis and read the cost.

b Don has only $2.50 in change. What is the largest size parcel he can post?

★5 Fran and her housemate Cindy share the cost of the utilities. A section of their latest electricity bill is shown. The graph shows their electricity usage over a year divided into quarters, e.g. the bill for Jan-17 covers the Oct-16 to Jan-17 period.



a Identify the time period when Fran and Cindy used the most energy.

b Approximately how many kWh did Fran and Cindy use in the months of April to July 2017?

> Hint What would happen in these months to require more energy?

c There seems to be a big difference in the energy used in the month of January in 2017 and in 2018. Give some possible reasons for this.

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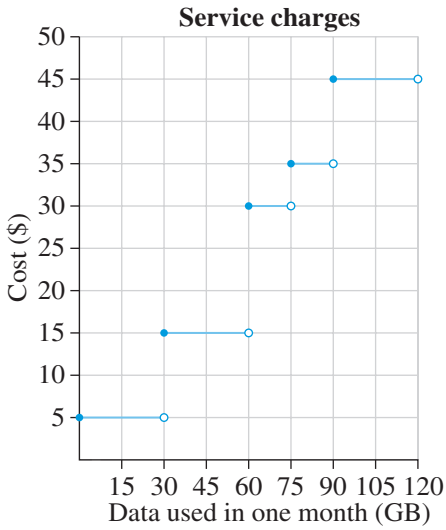
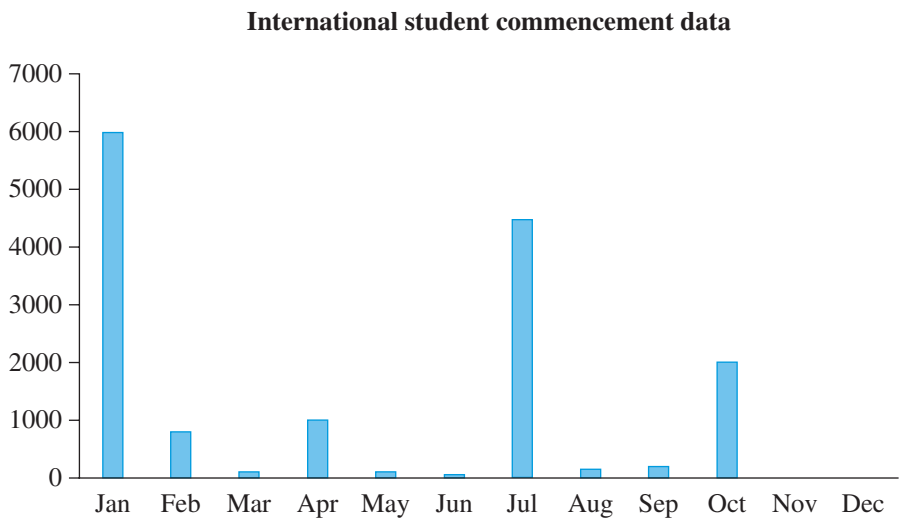
★6 A certain media streaming service charges its customers according to how much data they use each month. A summary of the charges is displayed in the step graph shown.



- **a** Determine how much it would cost if 45 GB of data is used in one month.
- **b** How much would it cost if 60 GB of data is used in one month?
- **c** How much would it cost if 80 GB of data is used in one month?
- **d** If a customer receives a bill of $30 for the month, how much data might they have used in that month?
- **e** If a customer receives a bill of $45 for the month, how much data might they have used in that month?
- **f** Calculate the difference between the monthly cost of a customer who uses 17 GB in one month and someone who uses 63 GB in one month.

Hint Which operation (+ − × ÷) is for the word 'difference'?

★7 The column graph shows international school student commencements in a monthly time series format.



Use the graph to complete the following.

- **a** Suggest how the vertical axis should be labelled.
- **b** Which month(s) has the most commencements?
- **c** Explain why you think the most commencements occur in this month(s).
- **d** Approximately how many students in total commenced in February, March and April?

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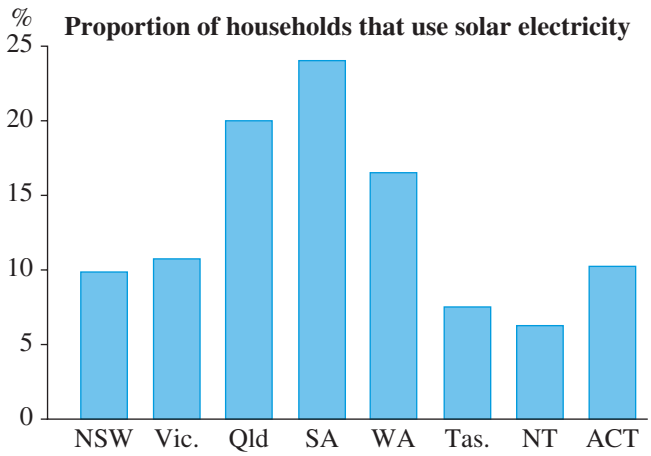
★8 The following graph shows the proportion of households that use solar electricity in the different States of Australia.



a Approximately what proportion of households use solar electricity in Queensland?

b Approximately what proportion of households use solar electricity in Tasmania?

c Identify which State has the highest proportion of households that use solar electricity.

d Identify which State has the lowest proportion of households that use solar electricity.

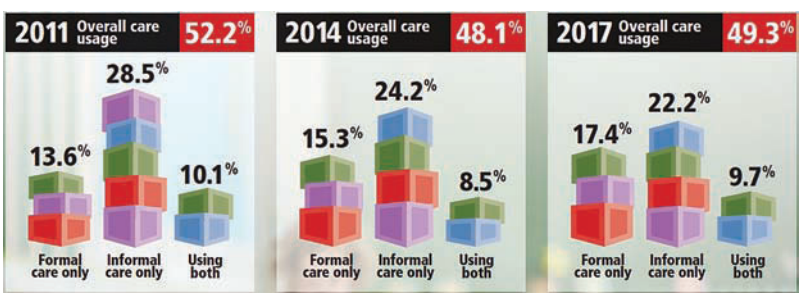
e It has been suggested that many people in South Australia use solar electricity owing to the frequent occurrence of power outages during the summer months. Does this graph support this suggestion? Justify your answer.

★9 A summary of children aged 0 to 12 years who usually attended care in 2011, 2014 and 2017, is shown.

a Determine the percentage of children aged 0 to 12 years that attended only formal care in 2017.

b Determine the percentage of children aged 0 to 12 years that attended only informal care in 2014.

c Explain how the percentage of children aged 0 to 12 years attending only informal care changed over the years of 2011, 2014 and 2017.



Source: Childhood Education and Care (www.abs.gov.au/childcare)

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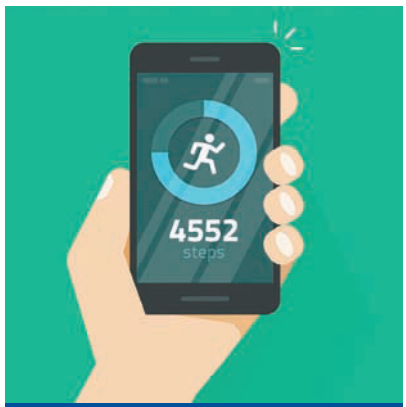
5B Pie graphs and picture graphs

LEARNING GOALS

- Read and interpret information presented in pie graphs
- Read and interpret information presented in picture graphs

How are pie and picture graphs essential?

Pie graphs (circle graphs or sector graphs) and picture graphs (pictograms or pictographs) give an excellent visual representation of statistical information. They are commonly used to compare sets of data. Being able to read and interpret them is an essential skill.



Pie and picture graphs are used in everyday life. It is essential that we learn how to read and interpret this useful data.

WHAT YOU NEED TO KNOW

- A **pie graph** is a circle divided up into sectors, with each sector representing that percentage of the whole.
- Pie graphs are useful for displaying data where it is important to compare the sizes of the parts that make up the whole.
- Pie graphs are commonly used in the media to display the size of the components that add up to the total value of a category.
- A **picture graph** is a pictorial display of data, using symbols, **icons** or pictures, to represent different quantities.
- A common type of picture graph is like a **dotplot** with icons replacing dots.
- A picture graph must include a key/legend to show the value of the icons used.
- The size of the icons should relate to the quantities they represent. Icons representing the same quantity should be the same size.
- A fraction of the symbol used will represent that fraction of the value of the symbol.
  - For example: Half of the symbol represents half of the value of the symbol. So, if the whole symbol represents 10, then half of the symbol represents 5.
- Picture graphs and pie charts can communicate information visually, overcoming differences in language, culture and education.

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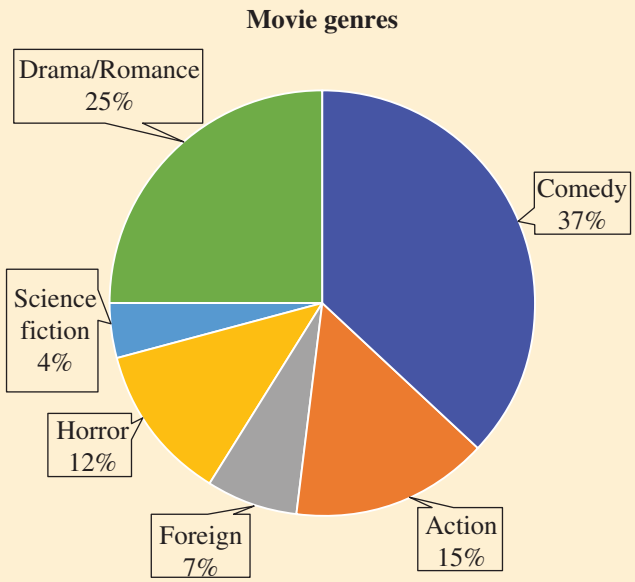
Example 3 Reading and interpreting information presented in a pie graph

A Year 11 class is surveyed about their preferred movie genre (a category such as thriller or romance).



a Identify the most favoured movie genre.
b Calculate the total percentage of Horror, Drama/Romance and Action.

WORKING	THINKING
a The most favoured movie genre is Comedy	Pie graphs are a good way to show relative sizes. At a glance, it is easy to see which movie genres are the most preferred and which are the least. The largest sector represents Comedy (37%), therefore it is the most preferred genre in the class.
b Sum = 12% + 25% + 15% = 52% The total percentage is 52%.	List each genre and find the sum. Horror = 12% Drama/Romance = 25% Action = 15%

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Example 4 Reading and interpreting information presented in a picture graph

A soccer team records their goals for the season.

a Identify the player who scored the most goals.
b Calculate the percentage of the goals that were scored by Adrian for the season.

WORKING	THINKING
a $4\frac{1}{2}$ balls are shown for Catarina.	The key shows that a complete ball represents 10 goals and half a ball represents 5 goals.
$4 \times 10 = 40$ $1 \times 5 = 5$ $40 + 5 = 45$ Catarina scored the most goals.	Therefore, Catarina has scored the most number of goals, scoring 45 goals for the season.
b Percentage $= \frac{\text{amount}}{\text{total}} \times 100$	Remember from previous chapters: Percentage $= \frac{\text{amount}}{\text{total}} \times 100$
Percentage $= \frac{25}{150} \times 100$ $= 16.67\%$	Adrian scored 25 goals. The total amount of goals scored by the team during the season is 150 goals.
The percentage of Adrian's goals for the season is 16.67%.	Substitute these values into the formula to find the percentage.

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Exercise 5B

FUNDAMENTALS

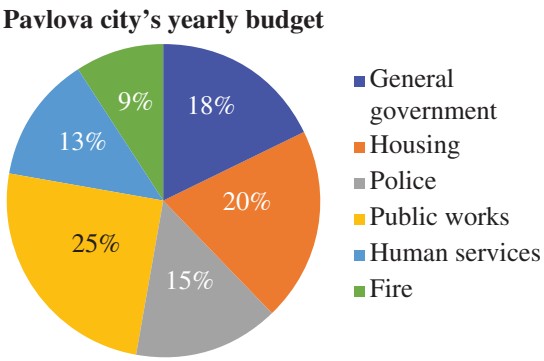
1 Demonstrate your understanding of terms by writing down the missing words in the following statements.

Hint Use WYNTK and the examples as a guide.

- **a** A pie graph is a circle divided into _____.
- **b** Each sector of a pie graph represents the _____ of the whole.
- **c** A picture graph is a pictorial display of data using _____.
- **d** When interpreting a picture graph a _____ is needed.
- **e** Picture graphs and pie charts are an excellent way to communicate _____.

Example 3

2 Use the pie chart to answer the following questions.



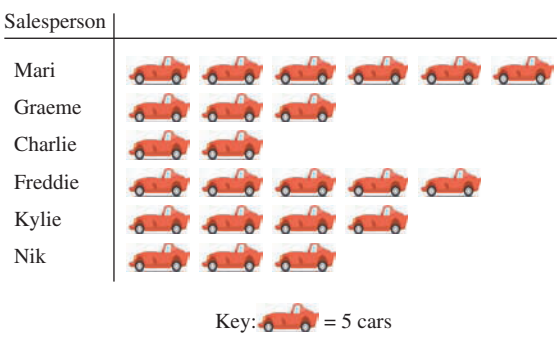
- **a** Identify which section of the budget receives the least amount.

Hint The smaller the sector, the smaller the amount it represents.

- **b** Calculate the total percentage of the budget allocated to police, housing and fire.
- **c** If the total budget for Pavlova City is $3 000 000, calculate how much public works would receive.

Example 4

3 The graph shows how many cars each salesperson at Freddie's Car Sales has sold in the past month.



Hint A picture graph includes a key to explain what each picture represents.

- **a** Identify who sold the most cars.
- **b** Determine how many cars Freddie sold.
- **c** Calculate the total percentage of the cars that Kylie and Charlie sold for the week.
- **d** Explain how 2 cars being sold could be represented in this graph. Use an illustration.
- **e** Explain how this type of graph could be used to help with sales.

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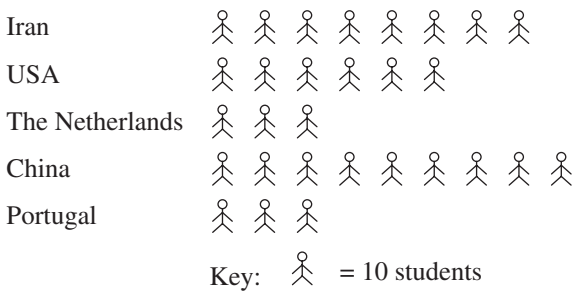
4 The graph shows the number of international students enrolled at Cairns State School.

a Determine the number of students from China.

b Calculate the percentage of international students from Iran.

International students enrolled at Cairns State School



APPLICATIONS

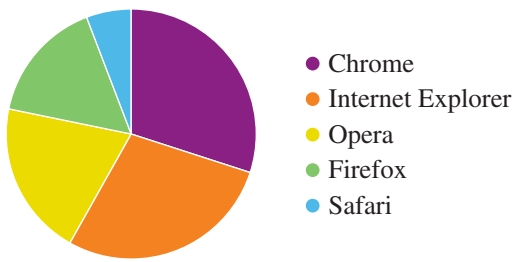
SF: 5–7 | CF: – | CU: –

★5 A pie graph is best used when aiming to work out the composition of something. If you have categorical data, then using a pie graph would work well, as each slice can represent a different category.

a List some advantages of using a pie graph.

b List some disadvantages of using a pie graph.

Web browser market share



c Suggest what informative component is missing from the pie graph shown.

★6 A group of students are surveyed about whether they have a part-time job and, if yes, what type of job they have. The survey's results are shown in the pie graph below.

Hint Each sector in a pie graph represents a percentage of the whole.

a Identify how many students have a part-time job as a retail assistant.

b Identify how many students have a part-time job as a cleaner.

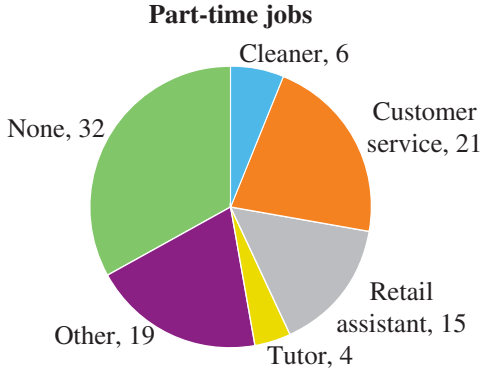
c What is the most common response?

d What is the most common type of part-time job?

e What is the least common response?

f Calculate how many of the students surveyed have a part-time job in total.

Part-time jobs



g Calculate the difference between the number of students who have a part-time job and the number of students who do not.

h In total, how many students participated in the survey?

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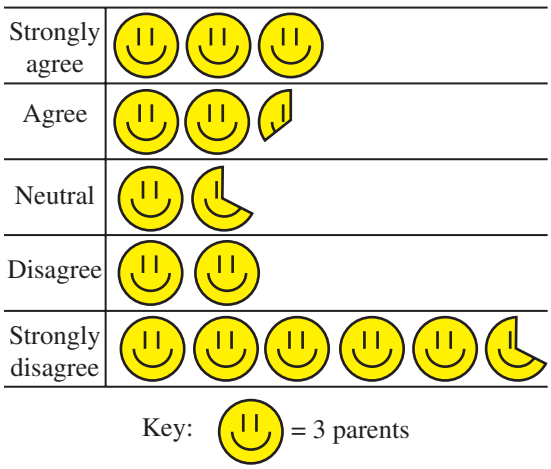
★7 A group of parents are surveyed regarding the statement: 'Every child should be forced to play at least one sport outside of school.'

Parents are able to give one of the following responses: strongly agree, agree, neutral, disagree, strongly disagree or they can choose not to respond. The results of the parents' responses are shown in the picture graph.



a Determine the number of parents who strongly agreed with the statement.

b Determine the number of parents who agreed with the statement.

c Identify the response that six parents selected.

d What is the difference in the number of parents who selected strongly disagree and the number of parents who selected strongly agree?

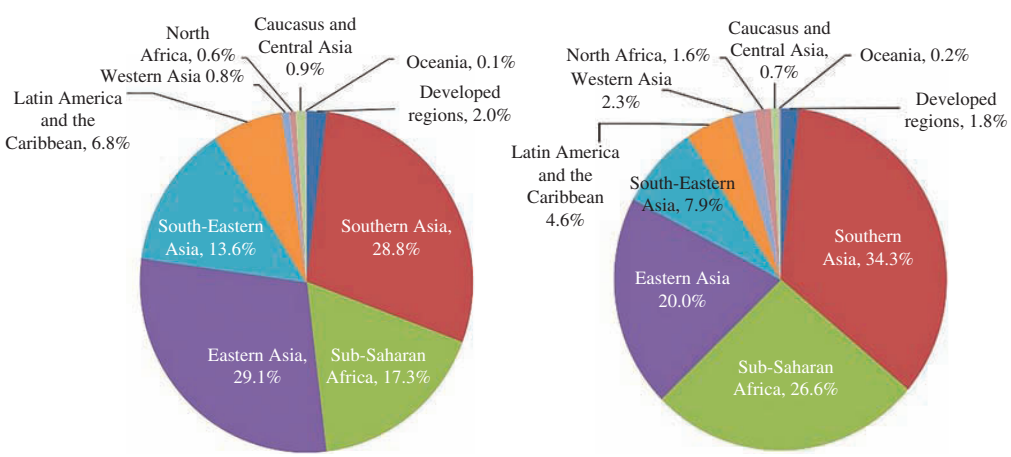
e In total, how many parents either strongly agreed or strongly disagreed?

f In total, how many parents gave a response?

g Given that 50 parents were asked, calculate how many chose not to give a response.

★8 Read these graphs.

Changing distribution of world hunger, 1990–2014



1990–92 Total = 1015 million **2012–14 Total = 805 million**

a **i** List in order the four regions that have changed the most.

ii By how many people did each region change from 1990–92 to 2012–14?

b Is world hunger getting worse or better? Justify your answer.

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5C Line graphs and conversion graphs

LEARNING GOALS

- Read and interpret information presented in line graphs
- Read and interpret information presented in conversion graphs

Why are line and conversion graphs essential?

Line and conversion graphs are used in everyday life, by many different people. Line graphs are especially useful and much used in the media, business and science for showing how a measurement such as price, temperature or mass varies over time. Conversion graphs are used in cooking (e.g. converting teaspoons to millilitres), measurement (e.g. converting pounds to kilograms or calories to kilojoules), money (e.g. converting Australian dollars to euros) and especially carpentry (e.g. converting inches to centimetres), to name just a few. Learning how to read and interpret line and conversion graphs is an essential skill that you will need throughout life.

Nurses use weight vs height conversion graphs as an indication of the health of babies and toddlers.

WHAT YOU NEED TO KNOW

- A **continuous variable** is any characteristic or quantity that can be measured.
  - For example: time, height, money, distance, volume, energy, etc.
- A **line graph** displays data points (x, y) connected by straight line segments.
  - For example: A line graph could show the consumption of household energy in kilowatt hours in a 24-hour period.
- When time is one of the variables, it is usually shown on the horizontal axis.
- When the variables are **continuous**, estimates can be made between the points or beyond the points, to make a prediction.
- **Conversion graphs** are specific line graphs used to convert a measurement using one type of unit to the same measurement expressed in another type of unit.
  - For example: A conversion graph can be used to convert calories to kilojoules.

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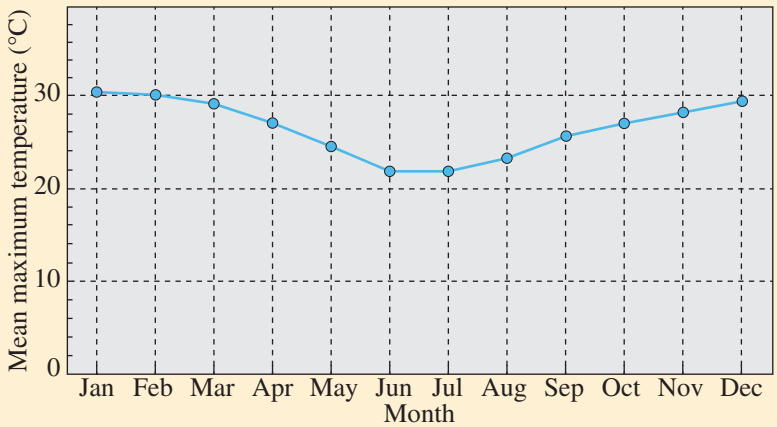
Example 5 Interpreting and analysing data from real-life graphs

The graph shows Brisbane's maximum temperature (°C) averaged for each month of the years 1999 to 2018.



a Approximately, what is Brisbane's average maximum temperature for February?

b On average, what are the two coldest months in Brisbane?

c Approximately, what is the difference in Brisbane's average maximum temperature between the months of February and June?

d If someone planning to visit Brisbane for a holiday preferred to visit when the temperature is between 24°C and 28°C, when would be the best months for them to travel?

WORKING	THINKING
a Approximately 30°C	Start on the x-axis and look for the 'Feb' label. Move vertically up to the graph's line and then left across to the y-axis to estimate the temperature.
b June and July	By finding the lowest values on the graph, the corresponding months for these temperatures can be found.
c February = 30°C June = 22°C Difference = 30°C – 22°C = 8°C	Reading off the graph, February is 30°C and June is 22°C, so the difference is 8°C.
d April, May, August, September, October or November would be the best months to travel because they have an average maximum temperature between 24°C and 28°C.	Find the months that have an average maximum temperature between 24°C and 28°C.

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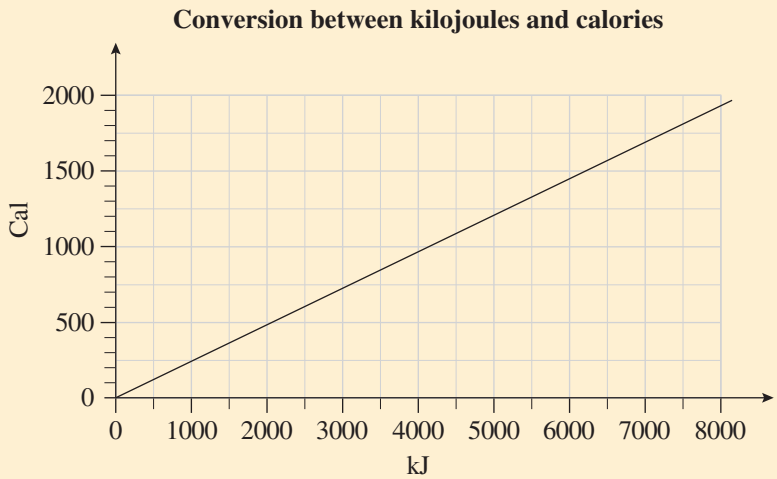
Example 6 Reading and interpreting information from a conversion graph

The following conversion graph shows the conversion between kilojoules (kJ) and calories (Cal).



a Using the conversion graph, convert the following kilojoules to calories.
- **i** 7500 kJ
- **ii** 6000 kJ
- **iii** 4000 kJ

b Using the conversion graph, convert the following from calories to kilojoules.
- **i** 250 Cal
- **ii** 1550 Cal
- **iii** 1200 Cal

WORKING	THINKING
a i 7500 kJ $\approx$ 1800 Cal	Identify the location of the kilojoule value on the horizontal axis. Move vertically up to the graph line. Move horizontally left to the vertical axis and read the corresponding calorie value.
ii 6000 kJ $\approx$ 1450 Cal	
iii 4000 kJ $\approx$ 950 Cal	

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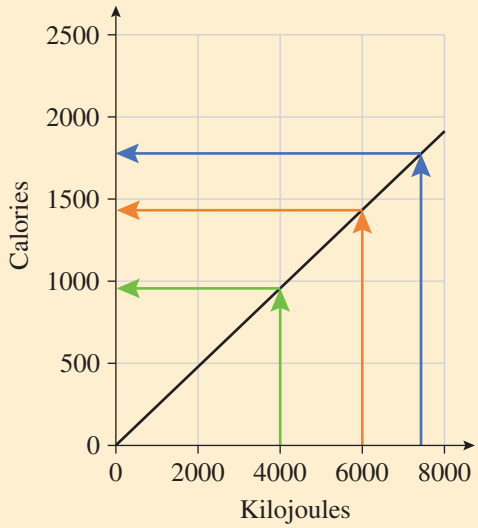
WORKING	THINKING

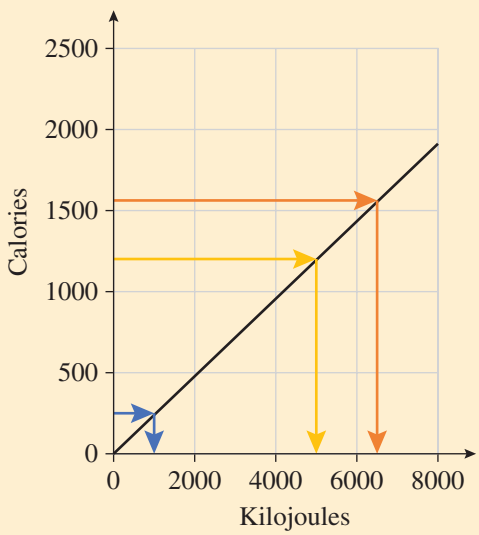


b i 250 Cal $\approx$ 1000 kJ

ii 1550 Cal $\approx$ 6500 kJ

iii 1200 Cal $\approx$ 5000 kJ

Identify the location of the calorie value on the vertical axis.
Move horizontally to the graph line.
Move vertically down to the horizontal axis and read the corresponding kilojoule value.



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Exercise 5C

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in the following statements.

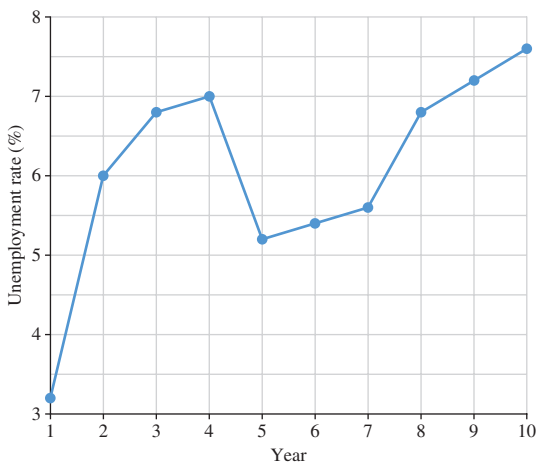
Hint Use WYNTK and the examples as a guide.

- **a** Time, height, money, distance, volume and energy are all examples of continuous _____.
- **b** A line graph displays data points connected by _____ line segments.
- **c** When time is one of the variables, it is usually shown on the _____ axis.
- **d** Conversion graphs can be used to _____ units of measurement.

Reading and interpreting graphs is an essential skill for most everyday jobs.

Example 5

2 This line graph shows the number of unemployed individuals in a town, over a period of 10 years.



- **a** Identify the variable that the horizontal axis is measuring.
- **b** Identify the variable that the vertical axis is measuring.
- **c** Construct a table showing the changing unemployment rate percentage from Year 1 to Year 10.
- **d** Decide whether the unemployment rate has increased or decreased overall.

Hint Is the overall trend of the line going up or down?

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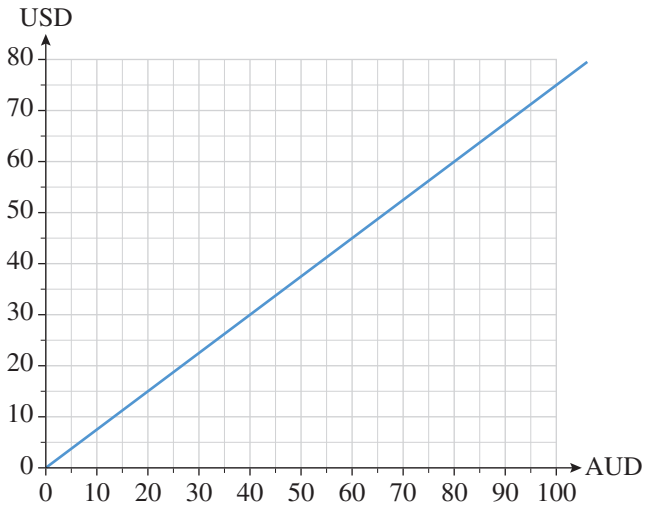
Example 6

3 The following conversion graph shows the conversion between Australian dollars (AUD) and US dollars (USD).



a Determine the value of A$20 in USD.

b Determine the value of A$80 in USD.

c Determine the value of US$30 in AUD.

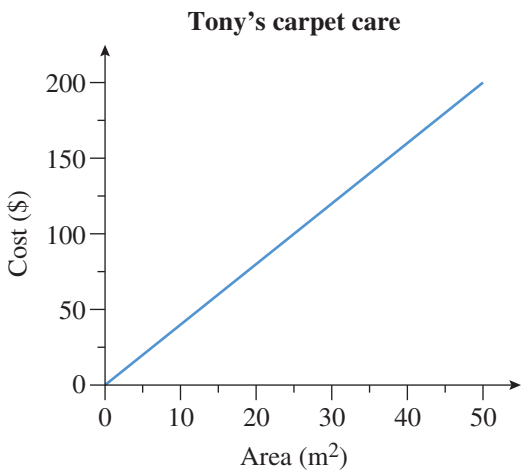
Hint Move vertically up the USD line. Move horizontally to the conversion line, then down to the corresponding AUD dollars.

d Determine the value of US$75 in AUD.

APPLICATIONS

SF: 4–8	CF: –	CU: –

★4 Tony has just started his own carpet cleaning business. He constructs his own conversion graph to provide quotes to his customers.



a A carpet has an area of 30 m^2. Use Tony's conversion graph to determine the cost of cleaning this carpet.

b Tony quotes $150 to clean a customer's carpet. Use the graph to determine the area of the carpet.

Hint Find the amount ($) along the vertical and move horizontally to the conversion line. Then move down to find the corresponding area (m^2).

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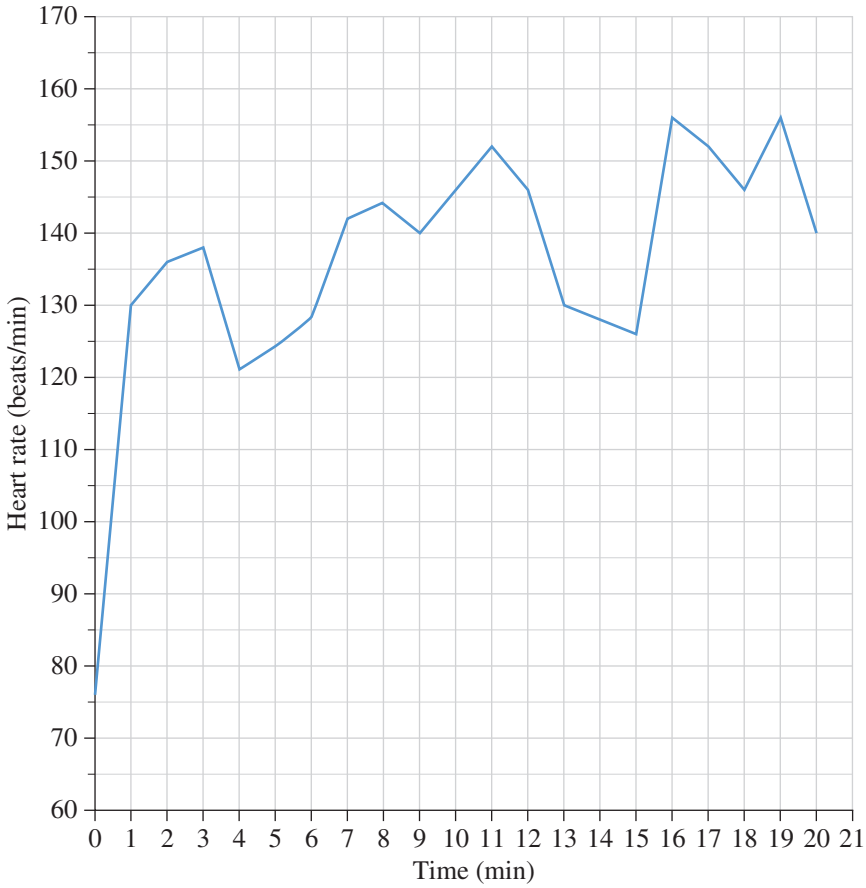
c A rectangular carpet has a length of 8.6 m and a width of 5 m. How much would Tony charge to clean this carpet?

d List some other uses for a conversion graph.

Hint First calculate the area of the carpet.

★5 Sandra wears a heart rate monitor while going for a run. A graph of her heart rate against time, in minutes, is shown.



a Determine is Sandra's heart rate when she first starts her run, that is, at 0 minutes.

b Determine Sandra's heart rate after 9 minutes of running.

c Determine Sandra's heart rate after 18 minutes of running.

d By how much does Sandra's heart rate increase between 15 and 16 minutes of running?

e Suggest a reason for the increase in heart rate in part **d**.

f By how much does Sandra's heart rate decrease between 3 and 4 minutes of running?

g Suggest a reason for the decrease in heart rate in part **f**.

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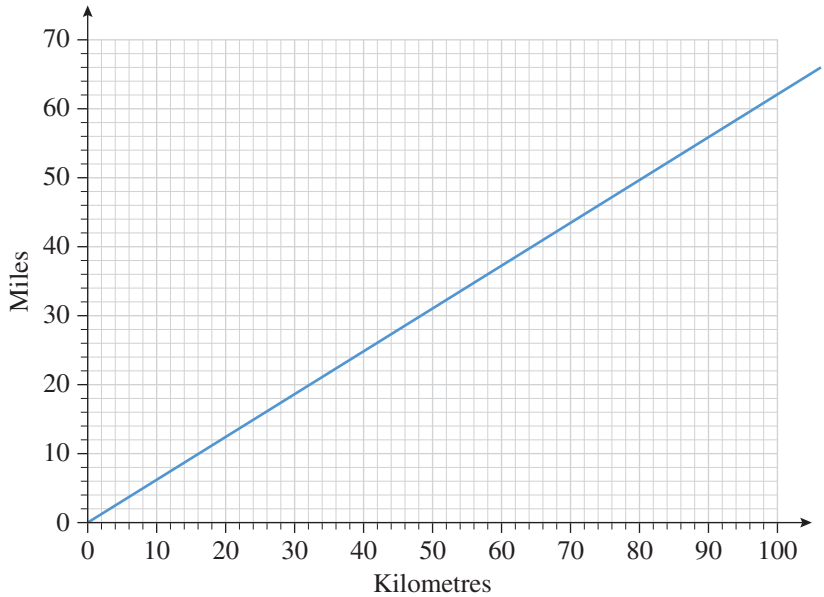
★6 The conversion graph between kilometres and miles is shown.



a Using the conversion graph, convert the following kilometres to miles. Estimate your answers to the nearest mile where necessary.

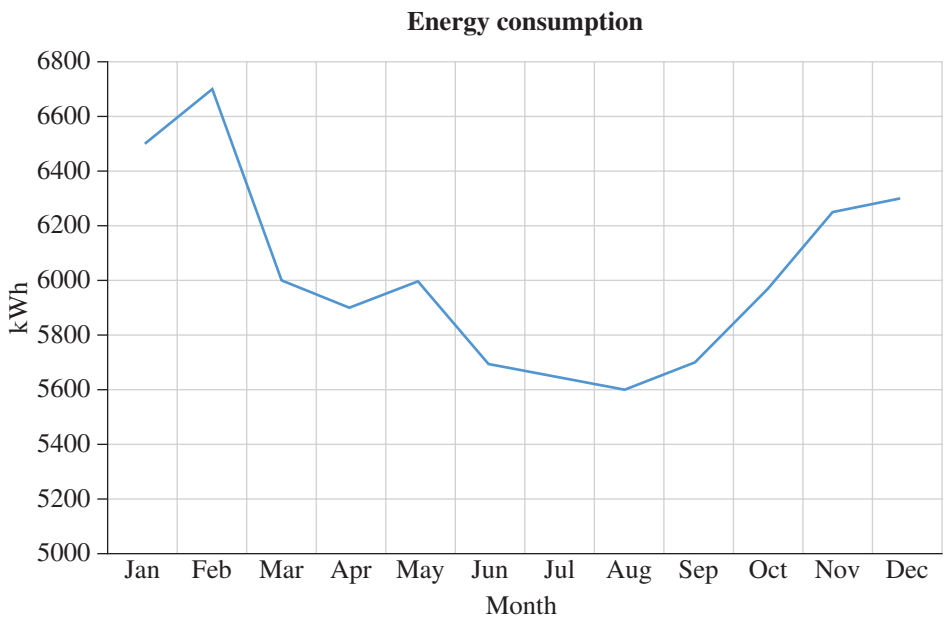
i 10 km **ii** 60 km **iii** 42 km **iv** 98 km

b Using the conversion graph, convert the following miles to kilometres. Estimate your answers to the nearest kilometre where necessary.

i 10 miles **ii** 30 miles

iii 34 miles **iv** 42 miles

★7 The line graph below shows the energy consumption, in kWh, per month for the Singh family, who live in Queensland.



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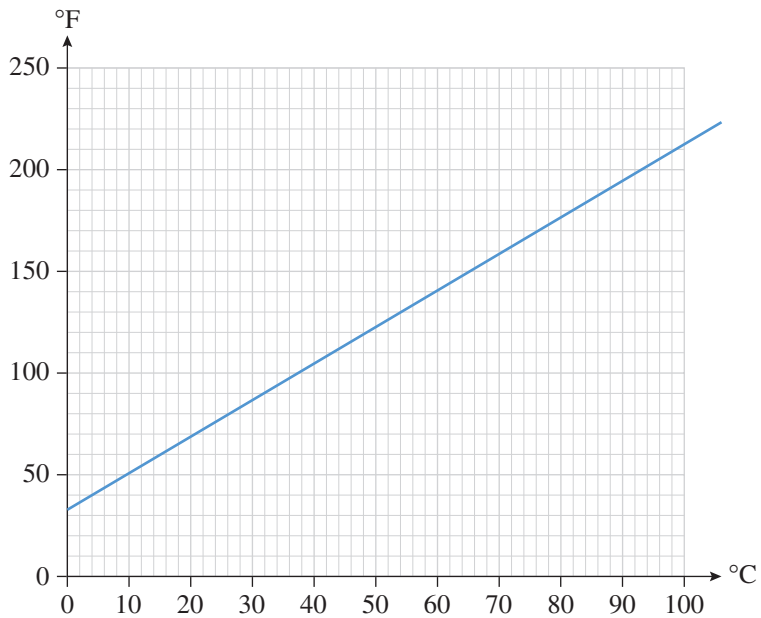
a Determine how many kilowatt hours (kWh) were used by the Singhs in March.
b Determine how many kilowatt hours (kWh) were used by the family in September.
c Determine how many kilowatt hours (kWh) were used by the Singhs in November.
d Identify the month in which the Singh family consumed the most energy.
e Suggest a reason for the result in part **d**.
f Calculate the difference in energy consumption between the months of May and June.

★8 In Australia temperature is measured in degrees Celsius (°C), whereas in the USA temperature is measured in degrees Fahrenheit (°F) . The temperature conversion graph between degrees Celsius and degrees Fahrenheit is given.



Hint In the USA, temperature is measured in degrees Fahrenheit (°F).

a In Australia water boils at 100°C. How would this be written in a cookbook published in the USA?
b Water freezes at 0°C. What is this in degrees Fahrenheit?
c On a particular day in New York, the maximum temperature is recorded as 100°F. Determine this temperature in degrees Celsius.

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5D Two-way tables

LEARNING GOAL

- Read and interpret information presented in two-way tables

Why are two-way tables essential?

Frequently, it can be very difficult to analyse results from a survey when they are presented as just a list of data values. A two-way table is a way of summarising these possible results into a more manageable fashion. Two-way tables are also used to compare the values between different variables. It is possible that an association exists between two variables and a two-way table can help identify that association.

Advertising companies employ data analysts to determine the age group that is most responsive to a particular ad. Two-way tables can analyse survey results.

WHAT YOU NEED TO KNOW

- As given in its title, a **two-way table** displays data from two **categories** of variables that are often connected to each other.
  - For example: Data from a car dealership about cars' fuel and wheel drive type.

	Uses petrol	Uses diesel	Total
4-wheel drive	15	55	70
2-wheel drive	30	20	50
Total	45	75	120

- Each category is labelled at the top and the left side of the table, with the information appearing in the four (or more) internal cells of the table.
- The 'Total' of each row appears at the right, and the 'Total' of each column appears at the bottom.
- The percentage of a value can be found by dividing it by the total and then multiplying it by 100.

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Example 7 Reading and interpreting a two-way table

The two-way table shows whether people are likely to purchase a product after viewing advertisements on videos.

Video advertisement survey				
	Advertisement A	**Advertisement B**	**Advertisement C**	**Total**
Likely to purchase	65	38	18	121
Unlikely to purchase	27	15	37	79
Total	92	53	55	200

a Identify how many people participated in the survey.
b Did all the survey participants watch all three advertisements?
c How many survey participants watched advertisement A?
d Of the people who watched advertisement A, how many are likely to purchase the product?
e What percentage of those who watched advertisement A are likely to purchase the product?
f Explain which advertisement, A, B or C, is more likely to persuade the viewer to purchase the product.

WORKING	THINKING
a The total number of survey participants is 200.	Two-way tables should include two sets of 'Total' cells: both vertical and horizontal. Determine the corresponding total in the bottom far right of the table.
b No, not all of the survey participants watched all of the advertisements: 92 people watched advertisement A, 53 people watched advertisement B, and 55 people watched advertisement C.	Reading the bottom row of the table, you can see a total of 92 people watched advertisement A, 53 people watched advertisement B, and 55 people watched advertisement C.

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WORKING	THINKING
c 92 people watched advertisement A.	Read the bottom row to see the total number of survey participants who watched advertisement A.
d 65 people of those who watched advertisement A are likely to buy the product.	Read through the row that states how many people are likely to purchase after viewing each advertisement.
e $\frac{65}{92} \times 100 = 70.7\%$ Of the people surveyed who watched advertisement A, 70.7% are likely to buy the product.	65 people out of the 92 who watched advertisement A are likely to buy the product. Calculate this as a percentage. Show working.
f Advertisement A: 70.7% are likely to buy the product. Advertisement B: $\frac{38}{53} \times 100 = 71.7\%$ are likely to buy the product. Advertisement C: $\frac{18}{55} \times 100 = 32.7\%$ are likely to buy the product. Hence, advertisement B is more likely to persuade the viewer to purchase the product.	Advertisement A has the highest number of people likely to purchase the product, but it also has the highest number of people who viewed the video. Advertisements B and C may have had proportionately more viewers who are likely to buy. For each advertisement, work out the percentage of viewers who are likely to buy. This value was worked out in part **e**, so write down the answer from part **e** for Advertisement A. Advertisement B: Calculate the percentage, showing your working. Advertisement C: Calculate the percentage, showing your working. Write down which advertisement has the highest percentage of viewers likely to purchase the product.

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Exercise 5D

FUNDAMENTALS

1 Copy and complete the following two-way tables by calculating the values of each total.

Hint: Use WYNTK and the examples as a guide.

a

	A	B	Total
C	8	5	
D	2	7	
Total			22

b

	A	B	Total
C	13	48	
D	32	25	
Total			118

2 Copy and complete the following two-way tables using the total values to fill in the missing values.

Hint: Each category is labelled at the top and the left side of the table, with the information appearing in the internal cells of the table.

a

	A	B	Total
C	4		11
D		6	15
Total	13	13	26

b

	A	B	Total
C		24	41
D	20		25
Total	37	29	66

APPLICATIONS

SF: 3–7 | CF: – | CU: –

★3 In a particular children's hospital, patients are assigned to wards according to their age. A nurse is given information regarding the number of patients on the two wards that she manages. This information is summarised in the two-way table below.

	Ward B	Ward C	Total
Boys	7	9	16
Girls	13	8	21
Total	20	17	37

a Identify how many boys in total are in wards B and C.
b Identify how many patients in total are girls.
c Determine the number of boys in ward C.
d Determine the number of girls in ward B.
e Calculate how many more girls than boys were in ward B.
f Calculate how many more boys were in ward C than ward B.

Hint: The 'Total' of each row appears at the right, and the 'Total' of each column appears at the bottom.

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Example 7 ★4 A survey asks some Year 11 students, 'What are your plans with regards to TAFE and travel after high school?'.

Comparing TAFE and travel			
	TAFE	**Not TAFE**	**Total**
Travel	43	10	53
Not travel	24	5	29
Total	67	15	82

a Using the two-way table, determine how many students participated in the survey.

b What is the total number of survey participants who have plans to go to TAFE?

c How many survey participants have plans to go to TAFE, but are not planning to travel?

d Calculate what percentage of the whole survey group are not travelling and not going to TAFE.

Hint The 'Total' of each row appears at the right, and the 'Total' of each column appears at the bottom.

★5 A survey asks some people, 'If you could have a new vehicle, would you want a sport utility vehicle (SUV) or a sports car?'.

Comparing sport utility vehicle (SUV) and sports car			
	SUV	**Sports car**	**Total**
Male	11	106	117
Female	63	20	83
Total	74	126	200

a Using the two-way table, identify how many people participated in the survey.

b Which gender prefer SUVs to sports cars?

c Identify which vehicle is preferred overall.

d Determine how many females prefer sports cars.

e What percentage of males prefer SUVs?

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★6 A survey asks some Year 11 students information about their test preparation.

Year 11 test preparation			
	Passed test	**Failed test**	**Total**
Completed review sheet	84	1	85
Did not complete review sheet	5	6	11
Total	89	7	96

a Using the two-way table, calculate the percentage of survey participants that failed the test.

b Calculate percentage of survey participants who completed the review sheet and passed the test.

c Calculate the percentage of survey participants who did not complete the review sheet and failed.

d Calculate the percentage of students who sat the test and did not complete the review sheet?

Hint The percentage of a value can be found by dividing it by the total and then multiplying it by 100.

★7 The table gives the statistics of those people who were on the ship RMS *Titanic*.

Survival statistics of RMS *Titanic*					
	First class	**Second class**	**Third class**	**Crew**	**Total**
Survived	203	118	178	212	711
Died	122	167	528	696	1513
Total	325	285	706	908	2224

a Calculate the percentage of passengers on the RMS *Titanic* that survived and were in first class.

b Calculate the percentage of passengers on the RMS *Titanic* that survived and were in third class.

c Calculate the percentage of crew members on the RMS *Titanic* that survived.

d Calculate the percentage of people who were on the RMS *Titanic* that died.

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5E Misleading graphs and tables COMPLEX

LEARNING GOAL

- Identify and interpret graphs that could possibly be misleading

Why is it essential to know about misleading graphs?

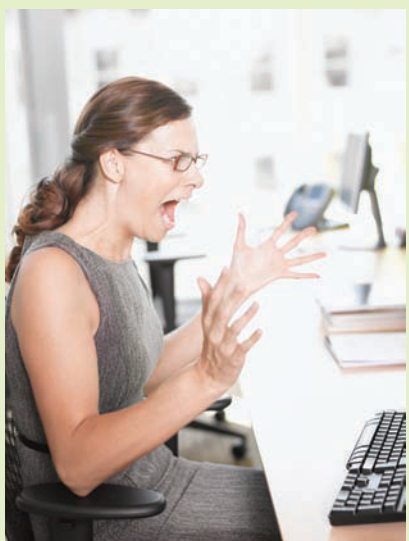
At times, when data is presented graphically, it can end up being misleading to the reader. This could be either accidental or intentional. A misleading graph could make certain data look better or worse than it actually is by changing the scale or using certain images. Misleading graphs can also persuade the reader to form certain opinions about the data being presented, by having leading statements as titles. Because of this, it is essential that you are able to identify and interpret misleading graphs by knowing what important features to look for.

Recognising the features of misleading graphs is a key analytical skill to avoid making a false conclusion.

WHAT YOU NEED TO KNOW

The following features are important when analysing whether or not a graph is misleading.

- **Title**
  - Is the title biased? Does it favour a particular viewpoint?
- **Axis or sector labels**
  - Are all axes and sectors labelled or have some been intentionally left out?
- **Axis scales**
  - Are the scales used for the axes acceptable, or have they been chosen to zoom into a particular feature of the graph?
  - Do the scales start at zero or are they broken scales?
- Uniform size of a symbol in a **pictograph**
  - Are the symbols (pictures or icons) the same size where they present the same quantities?



It is important to be able to interpret misleading graphs, so you will be able to identify incorrect data.

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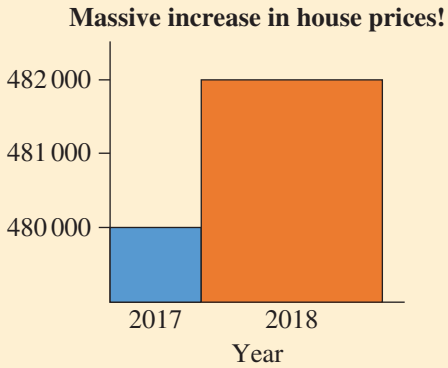
Example 8 Reading and interpreting a misleading graph

The graph has been used to entice people to buy now, as house prices are drastically increasing.
Describe how this graph is misleading in terms of:

a the title
b the labels
c its source
d its size
e the scale used



WORKING	THINKING
a The graph is misleading due to the title using biased language (e.g. use of the word massive).	The title uses bias words, such as massive.
b The *y*-axis title has not been included. The prices could be average house prices or upper house prices or lower house prices, which makes the graph misleading.	The *y*-axis does not have a title.
c The source of the data has not been given. The graph is misleading because the graph could have been fabricated.	The source has not been given.
d The width of the columns in the graph are different, where 2018 is larger. The graph is misleading, as the 2018 column is not only taller but it is also wider.	Measure the width of the columns; one is wider than the other.
e The 2017 price was $480 000 and the 2018 price was $482 000, being a difference of only $2000.	Read the graph, to see how much house prices have actually risen.
This graph is misleading, as it has used scale manipulation and omitted baselines to create the impression of a larger difference than is really there.	Omitting baselines, or not starting at zero, is one of the most common ways data is manipulated in graphs. This misleading tactic is frequently used to emphasis the difference between groups.

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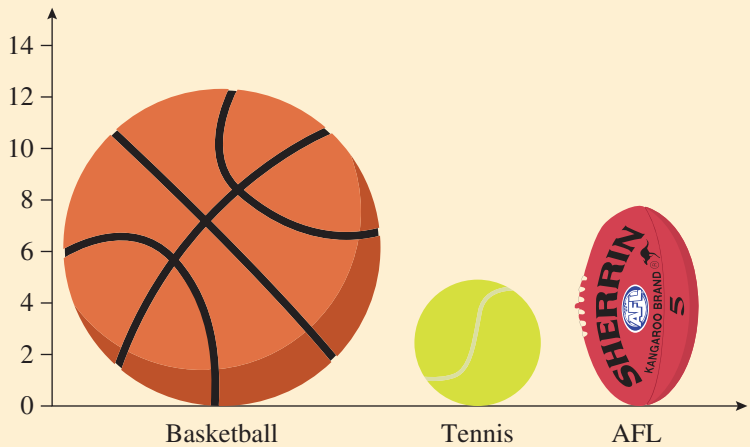
Example 9 Identifying and interpreting graphs that could be misleading

The graph below is a picture graph created by James, summarising the results of a survey he conducted, where he asked students which sport they preferred out of basketball, tennis and AFL.



a Describe what conclusions could a reader make from this graph.
b Identify and interpret some of the features that make this a misleading graph.
c Describe how James should change his graph so it is not misleading?

WORKING	THINKING
a Basketball is by far the most popular choice.	The basketball looks at least four times bigger than the AFL ball, suggesting that basketball is more than four times as popular.
b The size of the balls used to display the data is misleading. Basketball is the most popular choice, but not by as much as the images suggest.	From looking at the scale, 12 survey participants selected basketball and eight selected AFL. This is not as big a difference as shown by the difference in the size of the balls.
c Change the graph to a picture graph using multiple images of the balls, each of the same size. Or create a column graph and have the images of the balls within the columns so that the images are all the same width.	When creating a graph, be sure that all columns are the same width and nothing looks bigger than it should.

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Exercise 5E

FUNDAMENTALS

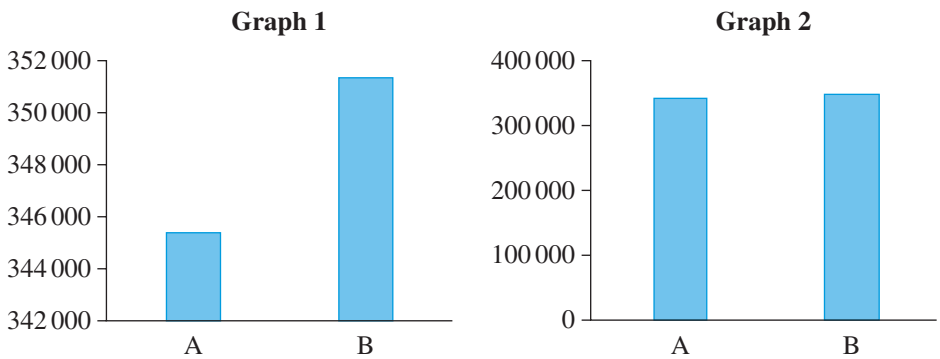
1 Demonstrate your understanding of terms by writing down the missing words in the following statements.

Hint Use WYNTK and the examples as a guide.

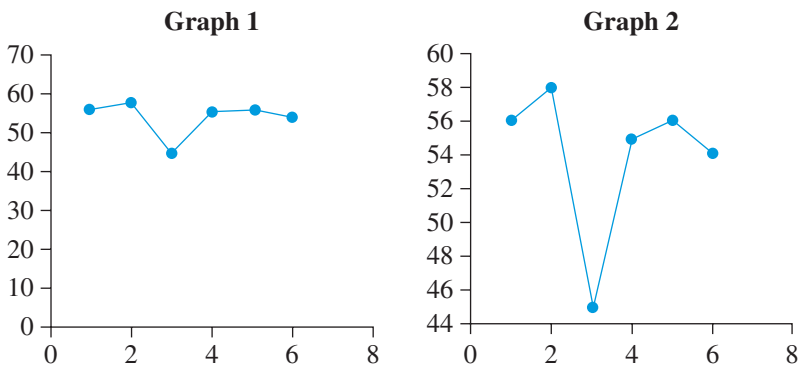
- **a** A graph that has altered features to skew the interpretation of the data is known as a _____ graph.
- **b** A graph title with a particular viewpoint may be _____.
- **c** A scale that does not start at zero is known as a _____ scale.
- **d** A picture graph must have images or icons that are the same _____.

2 The following are pairs of graphs that have been drawn from the same data. Identify the misleading and the non-misleading graph, giving a reason for your answer.

a



b



Hint Which sections of each graph could be biased?

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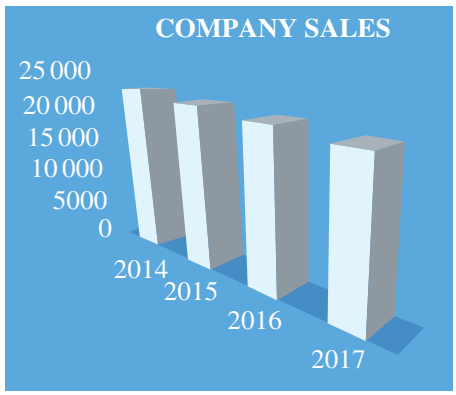
APPLICATIONS

SF: – | CF: 3–4 | CU: 5–9

Example 9 ★3 The graph shows a company's sales of a particular product for the years 2014 to 2017.



a Decide if it is possible to easily see if the sales in 2017 are more or less than in previous years?

b What conclusions could someone make from this graph?

c Identify and interpret some of the features that make this a misleading graph.

★4 The graph shows Australia's unemployment rate between February 2017 and November 2017.

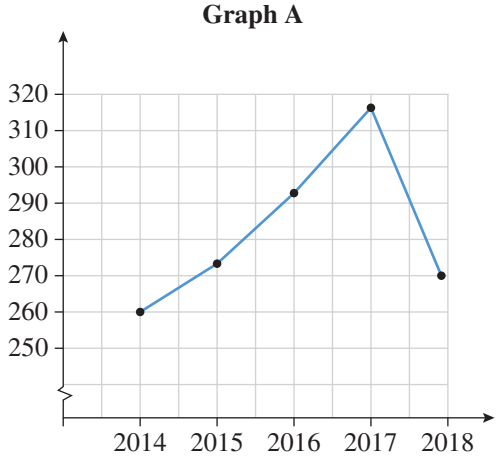
a Describe what conclusions a reader could make from this graph.

b Identify and interpret some of the features that make this a misleading graph.

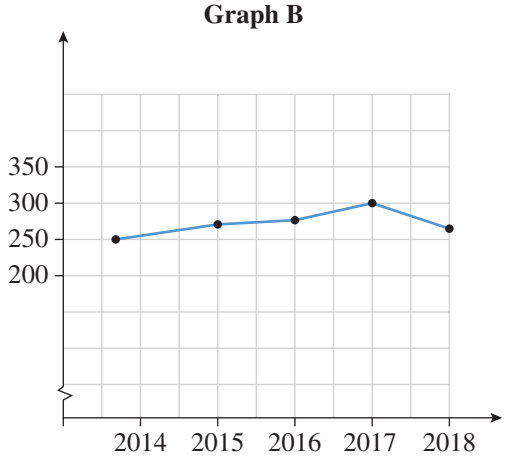
★5 The two graphs below, illustrating the same data, are being considered by a high school to show prospective students and their parents.

Year 11 enrolment numbers at Top Heights High School

Graph A



Graph B



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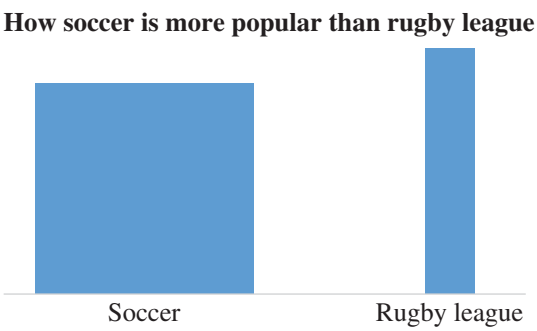
a By comparing the graphs decide whether or not both graphs convey the same message.
b Determine which graph gives a more accurate representation of the data.
c Describe the way in which graph (b) could be misleading.
d Explain why graph B would be considered by the school to use at a meeting with prospective students and their parents.

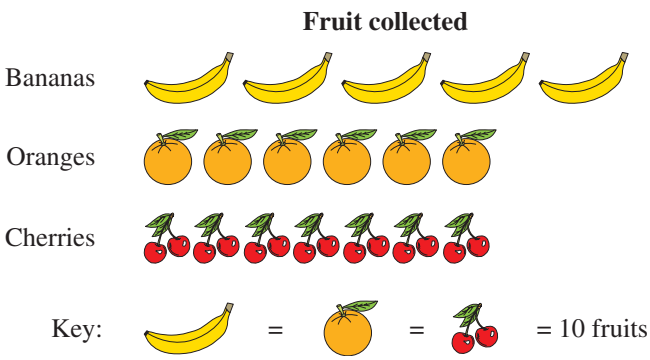
★6 John is trying to convince his friend that soccer is more popular than rugby league. He conducts a survey, asking people which sport they prefer out of soccer and rugby league. John summarises his data in a column graph, as shown on the right.



a What conclusions could you make from this graph?
b Identify and interpret some of the features that make this a misleading graph.
c Give some possible reasons for the graph being drawn this way.

Hint What message is John trying to send to his friends?

★7 The following graph is presented at a pickers' meeting.



a Determine how many of each fruit was collected.
b In what way is this graph misleading?
c Redraw the graph to present the results more accurately.

Hint Use a grid to ensure the symbols are the same size.

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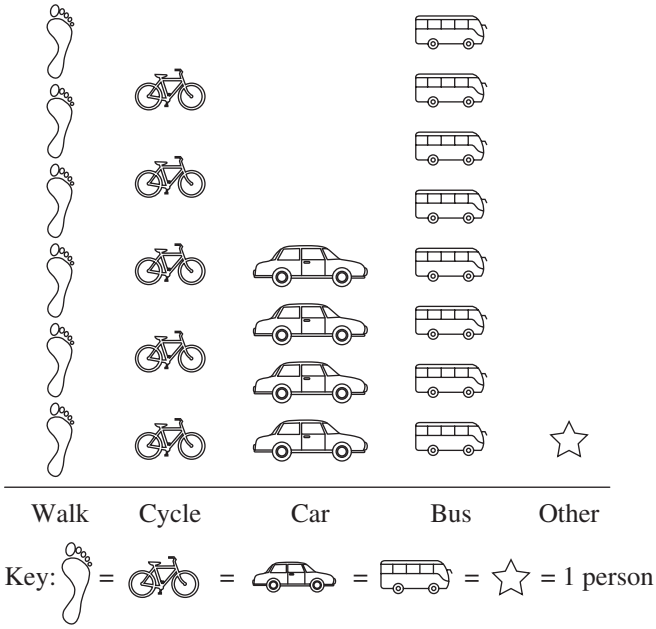
★8 Sarah is doing a research project for school, looking into how students get to school. She summarises her results in a picture graph, shown to the right.

a Describe what conclusions could be made from this graph.

b Identify and interpret some of the features that make this a misleading graph.

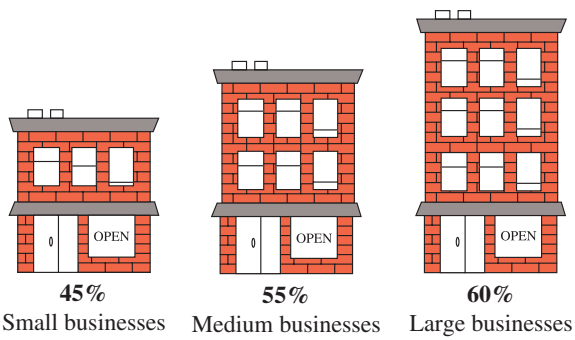


★9 The graph on the right reports on the proportion of businesses in a city that have a social media presence.

a Quickly reading the graph, what message is being presented?

b Read the graph more thoroughly; what is actually being displayed? Justify your answer.

c Describe the way this graph could be misleading.



Hint What is the purpose of the graph and how could it be biased?

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5F Interpreting tables and graphs COMPLEX

LEARNING GOALS

- Read and interpret tables, then justify your responses
- Read and interpret graphs, then justify your responses

Why is it essential to know how to interpret tables and graphs?

Tables and graphs are regularly found in the media and in factual texts. They are useful instruments for helping us make decisions in the home or at work. It is essential to learn the skills required to not only read and interpret tables and graphs, but also to be able to justify your reasoning when writing your responses.

It is important to know how to interpret tables and graphs.

WHAT YOU NEED TO KNOW

- You need to know what read, interpret and justify mean.
- **Read:** how to read a graph or table: take in the information and ensure you understand it. For this you have to know how graphs and tables organise and present information. You must be able to describe its characteristics and features, and state any relevant facts it shows.
- **Interpret:** use the information to recognise any trends and draw conclusions from the information. You must be able to understand the meaning of the graph or table.
- **Justify:** give detailed reasons or evidence to support your responses and conclusions.

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Example 10 Reading, interpreting and justifying a table

Interpreting tables found in factual texts

The Queensland Government is currently concerned with the amount of people failing the provisional licence test. The statistics on the right were taken from a randomly selected driving school, for a week.

Queensland learner driver test overview			
	Male	**Female**	**Total**
Passed	17	14	31
Failed	8	6	14
Total	25	20	45

a Calculate what percentage of people from the driving school failed their test.

b Determine whether a greater proportion of males or females failed the test.

c Interpret the answer to **b** in terms of whether gender is a significant reason for people failling the test. Justify your interpretation.

WORKING	THINKING
a $\frac{14}{45} \times 100 = 31.1\%$	Read all the information. Calculate the percentage who failed.
In a week, 31.1% of the people from this driving school failed their test.	
b $\frac{8}{25} \times 100 = 32\%$	Read all the information. Determine proportion through using percentage calculations of both males and females who failed.
32% of males from this driving school failed in a week.	
$\frac{6}{20} \times 100 = 30\%$	
30% of females from this driving school failed in a week.	
A greater proportion of males failed during this week.	
c Almost the same proportion of males and females failed their provisional licence test during the week.	Interpret what the proportions reveal.
32% of males failed and 30% of females failed. Even though the percentage of males who failed is higher, it is only 2%, which is not a significant amount.	Justify your responses.
This table is showing that gender is not a significant reason for people failing their provisional driving test.	

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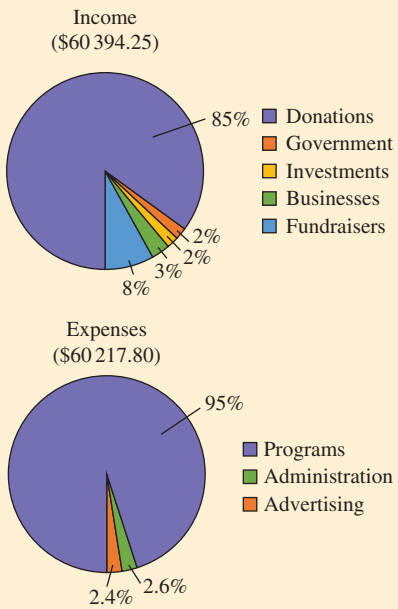
Example 11 Reading, interpreting and justifying graphs

Interpreting graphs found in factual texts

The pie graphs to the right were recently used in a charity's pamphlets. The 'programs' refer to the charitable work carried out to support people in need.

Income and expenses of a charity in 2017



a Identify the greatest income source.

b Calculate the difference in value between income and expenses.

c Describe what the graphs show overall, and compare the income and expenses of the charity. Suggest whether the graphs indicate that the charity's 2017 performance was satisfactory, in relation to its financial situation and supporting people in need.

WORKING	THINKING
a The greatest income source is donations, making up 85% of income.	Read all the information. Identify the graph that is relevant to income, and identify the largest sector of the pie chart.
b $\$60\,394.25 - \$60\,217.80 = \$176.45$ The difference between income and expenses is $176.45.	Identify the total income and expenses. Calculate the difference between income and expenses.
c The pie graphs show income and expenses for a charity in 2017. The total amount of income was enough to cover the expenses. (95%) of the charity's spending was on programs supporting people in need. Both of these indicate good performance as the charity did not lose money and spent nearly all of its money supporting people in need, which is what a charity should do. Very little was spent on administration and advertising.	Describe what the graphs show overall. Interpret the difference between income and expenses. Interpret how the charity's income was used. Decide whether the charity's performance was good, bad or in between, and justify your decision.

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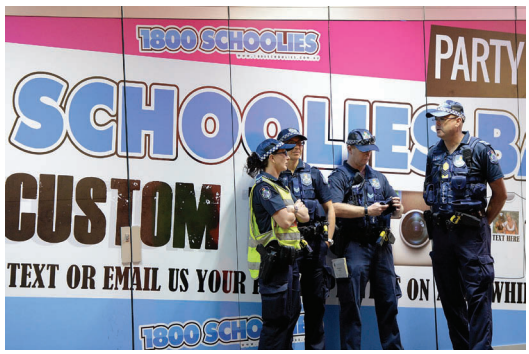
Exercise 5F

FUNDAMENTALS

Example 10

1 The table shows the number of males and females in a police force, according to rank.

	Male	Female	Total
Constable	87	56	143
Sergeant	25	7	32
Inspector	8	11	19
Chief Inspector	3	3	6
Total	123	77	200



a Calculate the percentage of females in the police force, according to the data.

b What percentage of Sergeants are male, according to the data?

c What percentage of Inspectors are female, according to the data?

d What percentage of Chief Inspectors are female, according to the data?

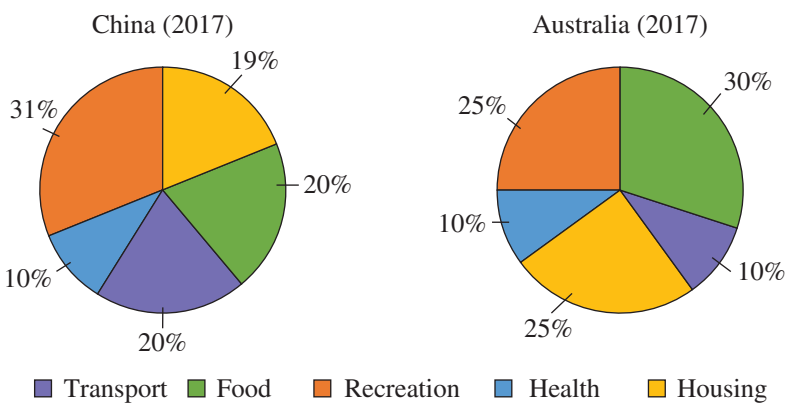
e Explain your interpretation of this table in terms of the number of males compared with females in the police force.

Hint The percentage of a value can be found by dividing it by the total and then multiplying it by 100.

Example 11

2 The pie graphs show the average household expenditures in China and Australia in the year 2017.

Comparison of houshold expenses in an average home



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a Which sector has the least expenditure in both countries?

b What percentage does each country spend on food?

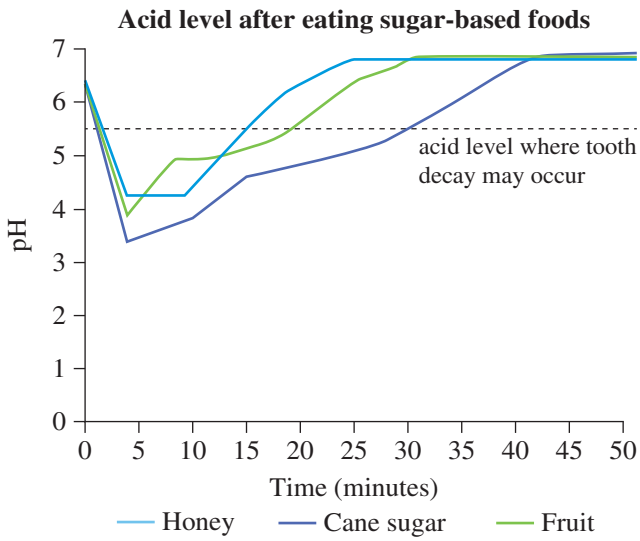
c Summarise the information by selecting and reporting the main features, and make comparisons where relevant.

> **Hint** When comparing, list all of the things that are the same (compare), then list all of the things that are different (contrast).

APPLICATIONS

SF:– | CF: 3–4 | CU: 7–8

★3 Use the graph on the right to answer these questions. Acid level is measured by the pH scale, where the lower the pH reading, the higher the acid level. Higher acid levels contribute more to tooth decay.



a How many minutes after eating a food with cane sugar is acid level at its worst (i.e. the most acidic)?

b How long after eating each of the following is the acid level unlikely to contribute to tooth decay?

i honey **ii** cane sugar **iii** fruit

c What is the pH level of eating fruit after 12 minutes?

> **Hint** What colour line is 'fruit'?

d What have you gathered from interpreting this graph?

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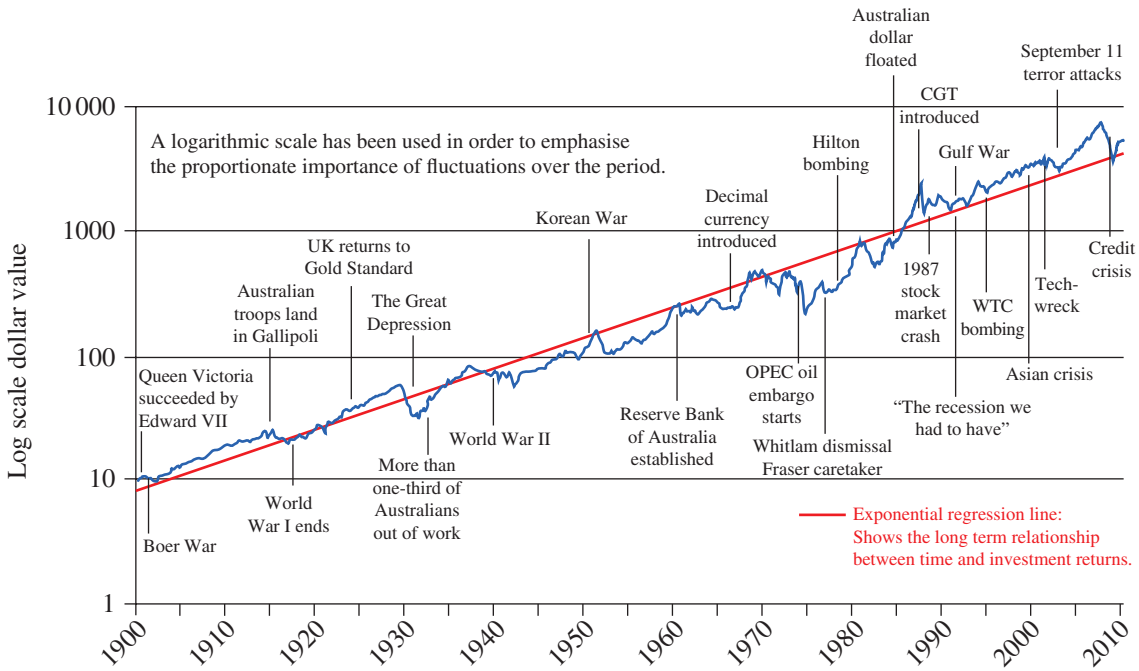
★4 Study the graph given and answer the following.

History of the Australian share market January 1990–March 2010



Source: MLC Investments Commercial & Industrial Index Monthly Averages (1875–1936), Sydney All Ordinaries Index Monthly Averages (1936–1979), All Ordinaries Share Price Index Monthly Averages (1980–1999), All Ordinaries Share Price Index Month End Price (2000–2009).

a What is the overall trend of the Australian share market, as shown in the graph?

b What four events in time caused the share market to fall?

c What are some current events that could affect today's share market?

d After interpreting the graph, what condition would you expect today's share market to be in?

> **Hint** Expand on the information from the graph into what's happening in today's market.

★5 A survey asked 1220 people in a population if they are satisfied with their body image or are dissatisfied with their weight, and if they are dissatisfied whether they think they are overweight or underweight. The results are shown in the two-way table. Use the information to complete the following.

	Body image			
	Satisfied	**Dissatisfied (overweight)**	**Dissatisfied (underweight)**	**Total**
Female	550	170	40	760
Male	300	80	80	460
Total	850	250	120	1220

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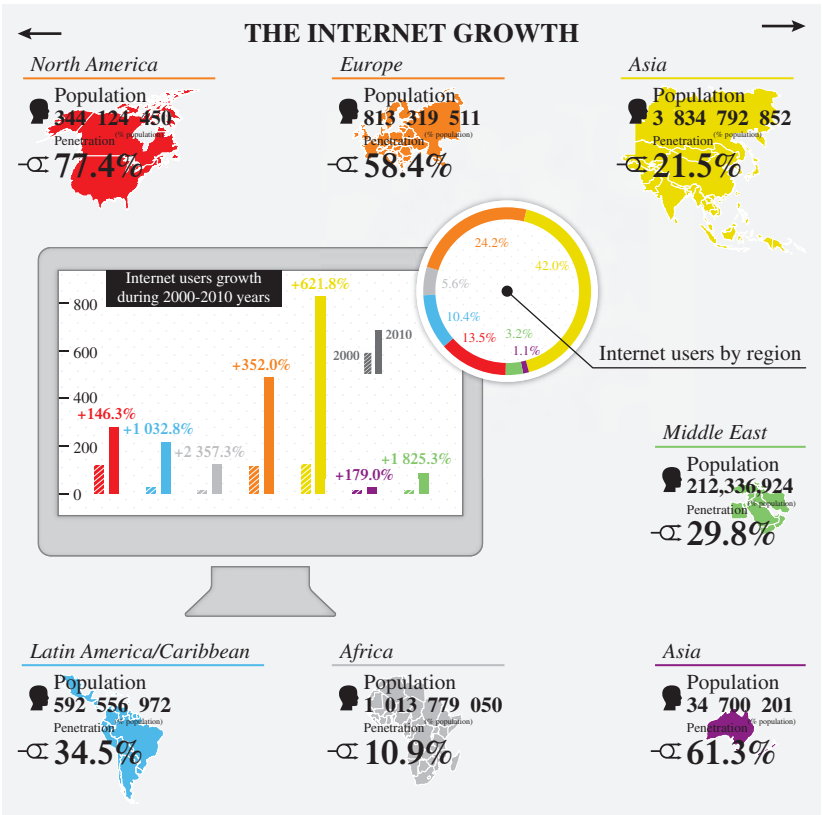
a Convert the counts of all female body images to percentages.

b Convert the counts of all male body images to percentages.

c Interpret the data to write a paragraph as to whether these body image categories are related to gender. Justify your answer.

★6 Use the statistics infographic to complete the following.



a Use the infographic to list the world's regions of internet penetration in order from highest to lowest.

b According to the infographic, what are the world's regions of highest growth percentage in terms of internet users between the years 2010 and 2017, in order from highest to lowest?

c Interpret the data to write a paragraph discussing internet penetration in Asia.

Hint Don't be overwhelmed by all of the data. Explain one graph at a time, in a sentence.

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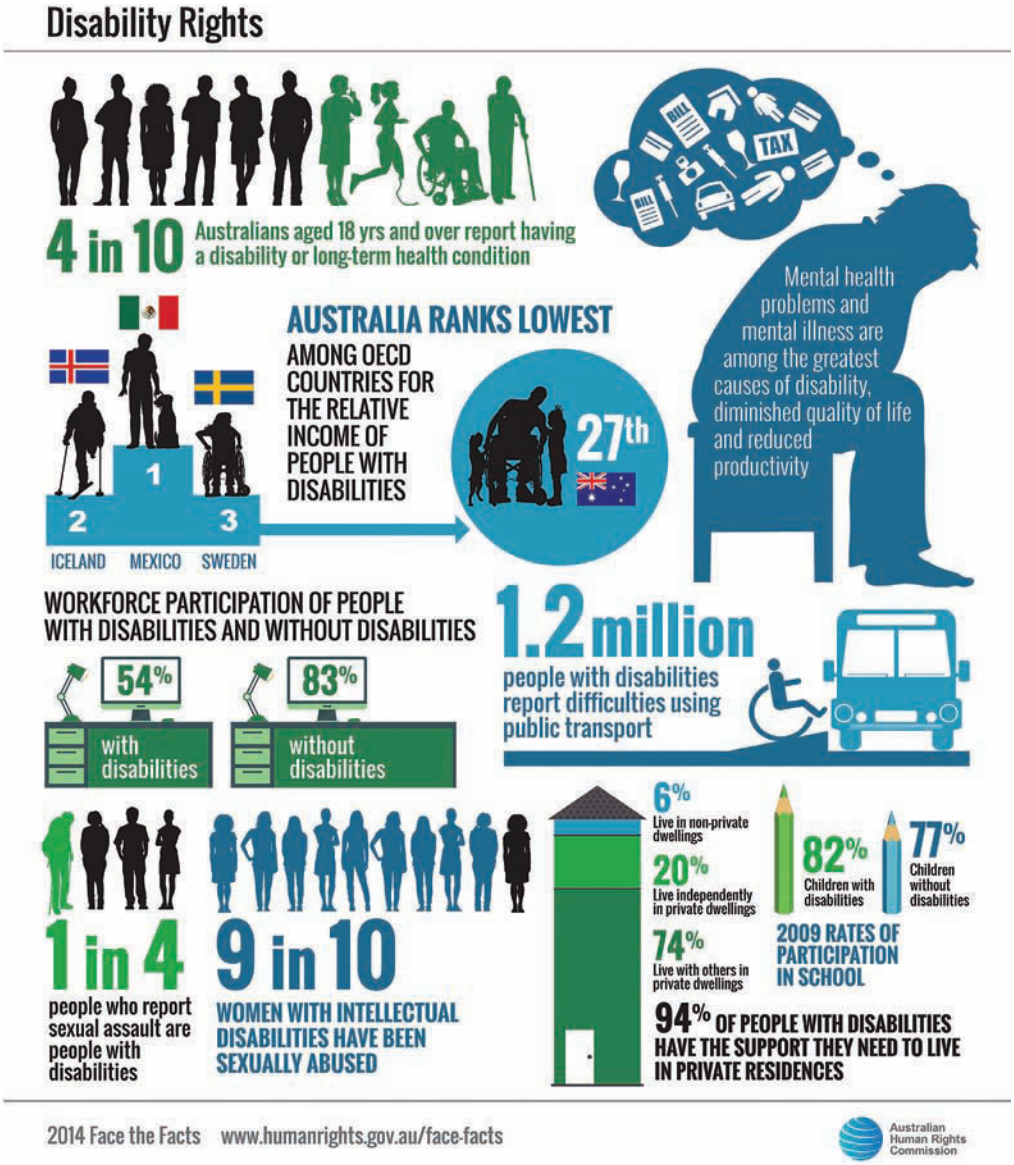
★7


Disability Rights
4 in 10 Australians aged 18 yrs and over report having a disability or long-term health condition
AUSTRALIA RANKS LOWEST
AMONG OECD COUNTRIES FOR THE RELATIVE INCOME OF PEOPLE WITH DISABILITIES
27th
2
1
3
ICELAND
MEXICO
SWEDEN
Mental health problems and mental illness are among the greatest causes of disability, diminished quality of life and reduced productivity
WORKFORCE PARTICIPATION OF PEOPLE WITH DISABILITIES AND WITHOUT DISABILITIES
54%
with disabilities
83%
without disabilities
1.2 million
people with disabilities report difficulties using public transport
1 in 4
people who report sexual assault are people with disabilities
9 in 10
WOMEN WITH INTELLECTUAL DISABILITIES HAVE BEEN SEXUALLY ABUSED
6%
Live in non-private dwellings
20%
Live independently in private dwellings
74%
Live with others in private dwellings
82%
Children with disabilities
77%
Children without disabilities
2009 RATES OF PARTICIPATION IN SCHOOL
94% OF PEOPLE WITH DISABILITIES HAVE THE SUPPORT THEY NEED TO LIVE IN PRIVATE RESIDENCES
2014 Face the Facts www.humanrights.gov.au/face-facts
Australian Human Rights Commission

Use the statistics infographic to complete the following.

a According to the infographic, what is the percentage of Australians aged 18 years and over who report having a disability or long-term health condition?

b What percentage of Australians who report sexual assault are people with disabilities?

c Interpret the data to write a paragraph discussing the issues affecting people with disabilities in Australia.

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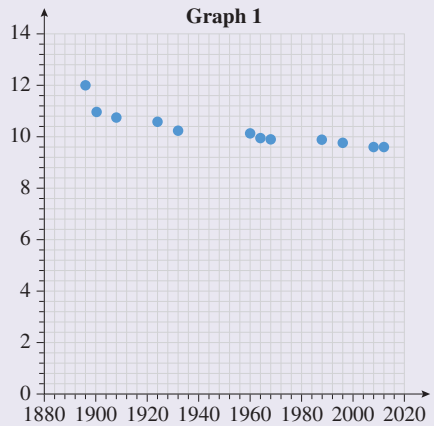
Problem-solving and modelling task

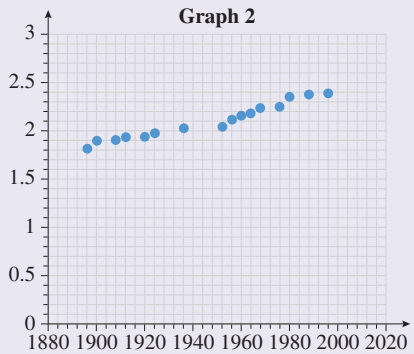
READING AND INTERPRETING GRAPHS

Background: Graphs of values over time can be very useful for displaying changes and trends – the general direction in which something is heading, for example, is it getting worse, or better? The record times or distances achieved in athletics are a good example. These six graphs for six different Olympics athletics events show when a new Olympic record was set, and what its value was.

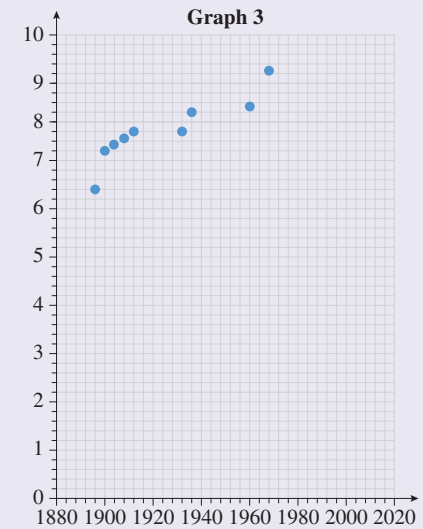
Graph 1



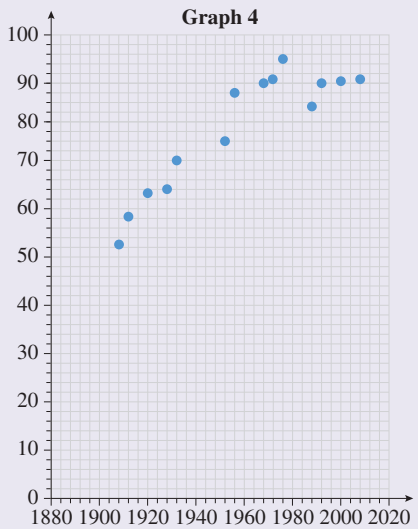
Graph 2



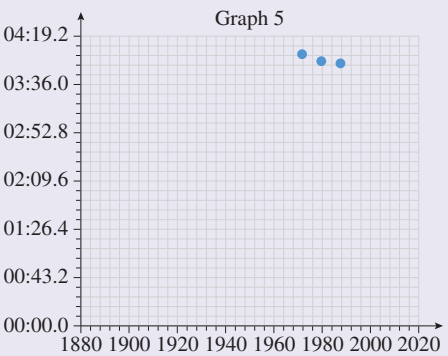
Graph 3



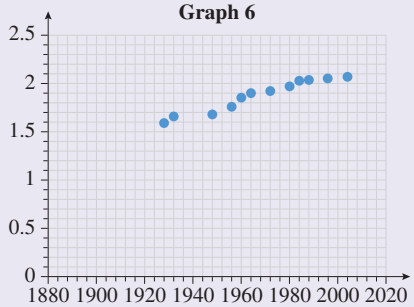
Graph 4



Graph 5



Graph 6



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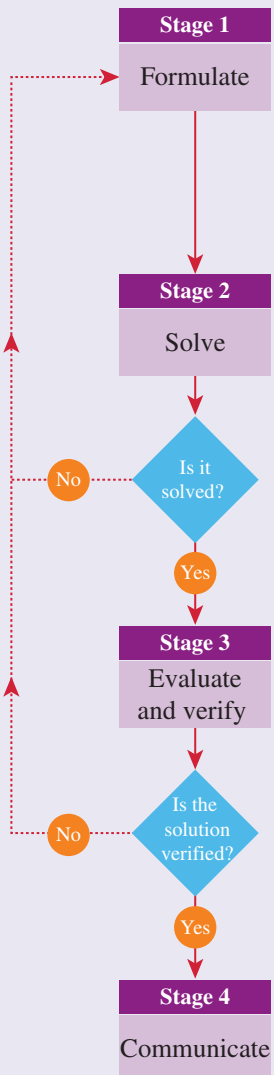
Task: these six graphs illustrate how Olympic records have changed over time in six different athletic events. Unfortunately, some parts of the information have been lost in transit.

Your task is to research Olympic athletic events. You must compare and contrast all events and conclude which event is the correct one for each graph. Determine what the units should be for the vertical axes. Explain why some graphs show a decreasing trend and some an increasing trend. Lastly, are there any unusual features on any of the graphs? Follow the problem-solving workflow diagram below and use the steps listed as a guide.



Stage 1: Formulate

Decide which details are missing in the graphs.

1. Describe what you think is needed for each graph.
2. Research the athletics events held at the Olympics.
3. Research the type of score measured for of each event.
4. Research the records of each event.

Stage 2: Solve

Once you have obtained your data, consider:

5. Suggest the event for each graph and what the vertical axis title and units should be.
6. Describe the trends in the records for each event.
7. Suggest any improvements which could be made to any of the graphs.

Stage 3: Evaluate and verify

8. Check that the Olympic records for each event matches the graph and that you can justify your responses with reasons.

Stage 4: Communicate

9. Communicate your findings in a short report giving your responses to all the questions and justifying them with your reasons.

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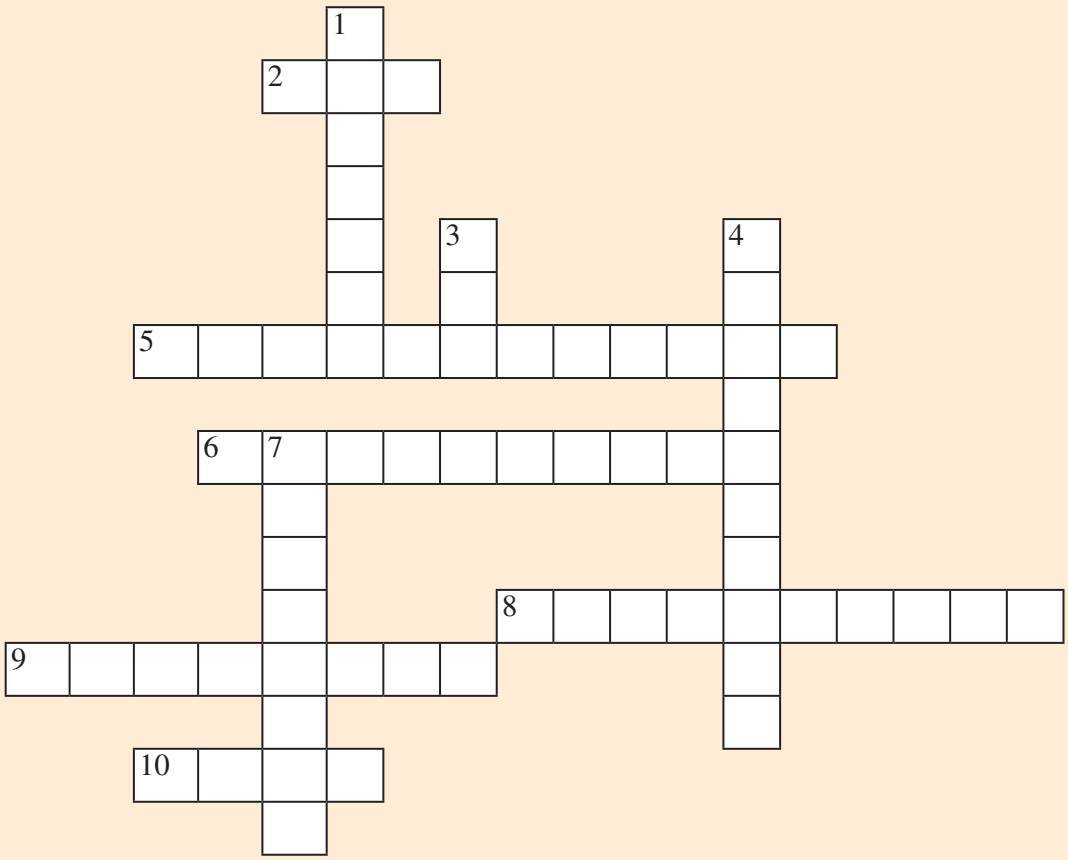
Puzzle



Across

2 Picture graphs must include a _____ to show the value of the icons used.

5 Conversion graphs can be used to convert _____.

6 A graph that has a scale that doesn't start at zero, or has certain information missing may be a _____ graph.

8 A quantity that can be measured is known as a _____ variable.

9 An open circle on a line segment in a step graph represents an _____ value.

10 A graph that consists of a series of horizontal line segments is called a _____ graph.

Down

1 A pie graph is a circle divided up into _____.

3 Another name for a column graph is a _____ chart.

4 Column graphs display the quantity of data in various _____.

7 A closed circle on a line segment in a step graph represents an _____ value.

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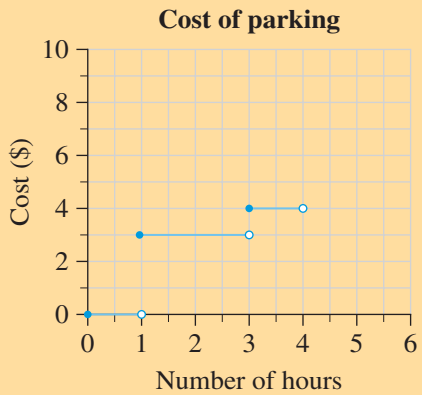
Chapter checklist

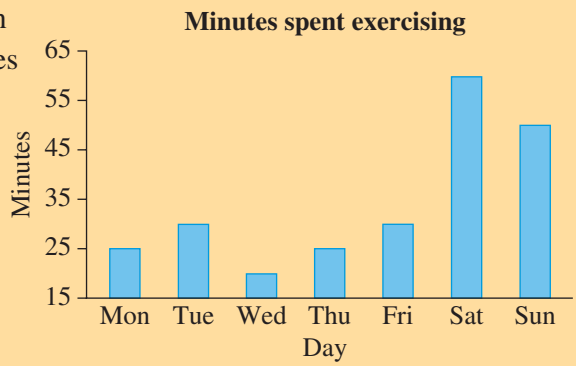
☐ I can read and interpret information presented in step graphs.

1 Given the step graph shown, what would be the cost for 3 hours of parking?



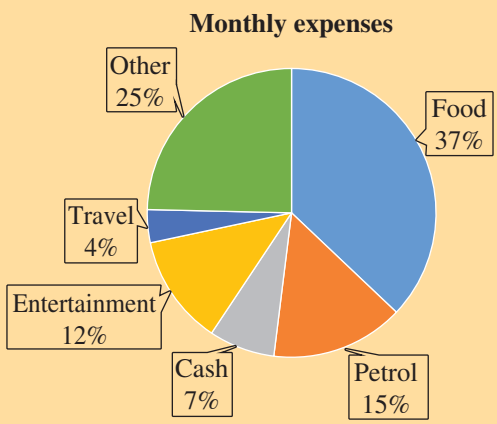
☐ I can read and interpret information presented in column graphs.

2 According to the column graph, how many minutes were spent exercising on Monday?



☐ I can read and interpret information presented in pie graphs.

3 Given the pie chart shown, what percentage of the monthly expenses is spent on entertainment?



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☐ I can read and interpret information presented in picture graphs.

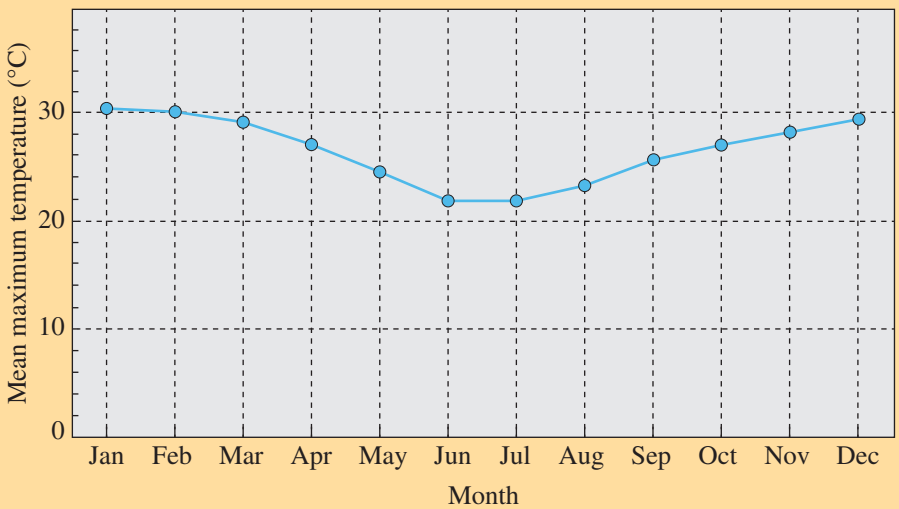
4 Referring to the picture graph, how many magpies were seen on the way home on Friday?

Day	Number of magpies seen on way home
Mon	3
Tues	4
Wed	3.5
Thurs	1
Fri	3

Key: = 2 magpies

☐ I can read and interpret information presented in line graphs.

5 According to the line graph, what was the mean maximum temperature in June?



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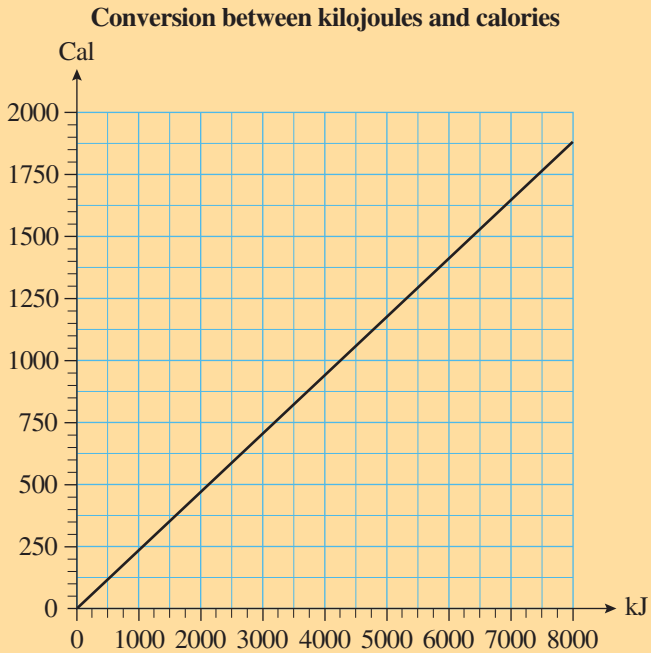
☐ I can read and interpret information presented in conversion graphs.

6 Using the conversion graph, convert 5000 kilojoules to calories.



☐ I can read and interpret information presented in two-way tables.

7 Given the two-way table, how many of the 2-wheel drive vehicles use diesel?

	Uses petrol	**Uses diesel**	**Total**
4-wheel drive	15	55	70
2-wheel drive	30	20	50
Total	45	75	120

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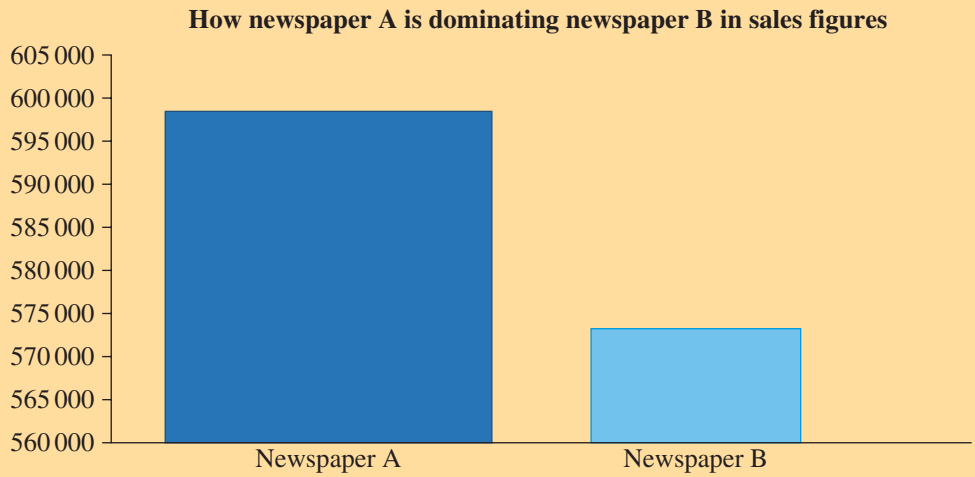
☐ I can identify and interpret graphs that could be possibly misleading.

8 For the column graph shown, what are some of the features that make this a misleading graph?



☐ I can read and interpret information presented in tables and graphs.

9 Which gender prefers sports utility vehicles over sports cars?

Comparing sports utility vehicles and sports cars			
	SUV	**Sports car**	**Total**
Male	11	106	117
Female	63	20	83
Total	74	126	200

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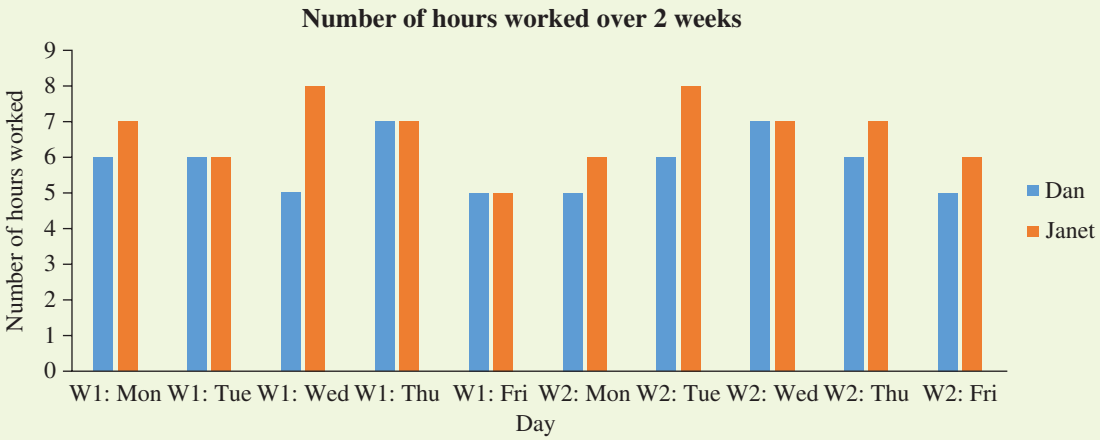
Chapter review

All questions in the Chapter Review are assessment-style.

Simple Familiar

1 Johan runs a café and has two workers, Dan and Janet. The number of hours worked in the café over a 2 week period by both Dan and Janet is shown on the graph.



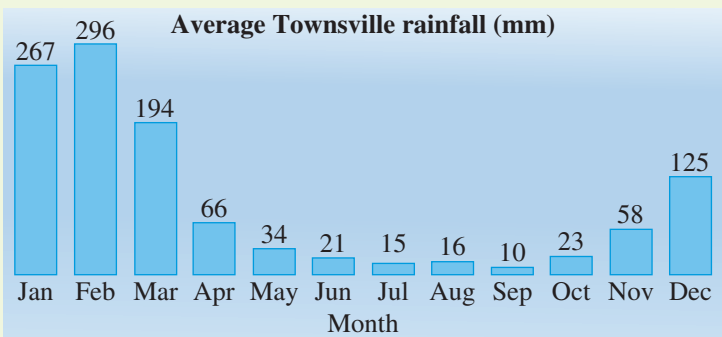
a How many hours did Dan work on the Monday of the second week?

b How many hours did Janet work on the Wednesday of the first week?

c On what days did both Dan and Janet work the same number of hours?

d Using the graph, who works more hours at the café? Justify your answer.

2 The following column graph shows the average monthly rainfall in Townsville, in millimetres.



a On average, how many millimetres of rainfall occurs during November?

b On average, how many millimetres of rainfall occurs during May?

c Which month has the highest rainfall on average?

d Townsville can be said to have a wet season and a dry season. Over which months do you think would be classified as the wet season? Justify your answer.

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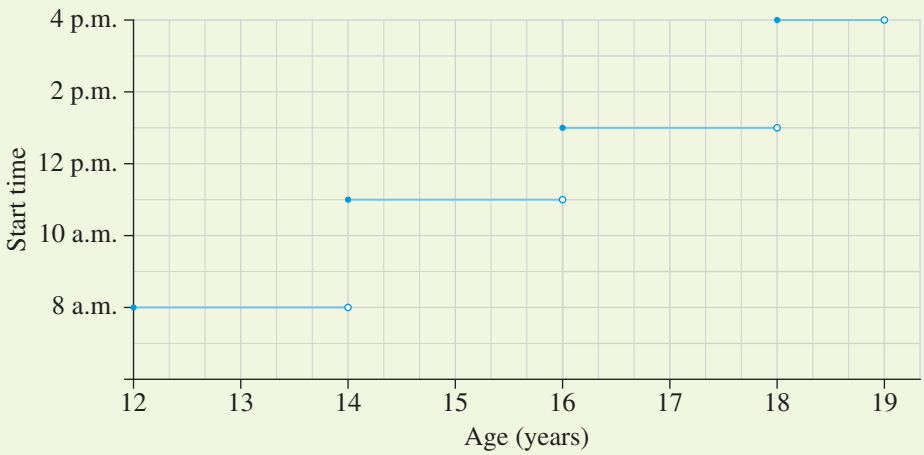
3 The step graph shows the event start times for an athletics competition, according to the participant's age.

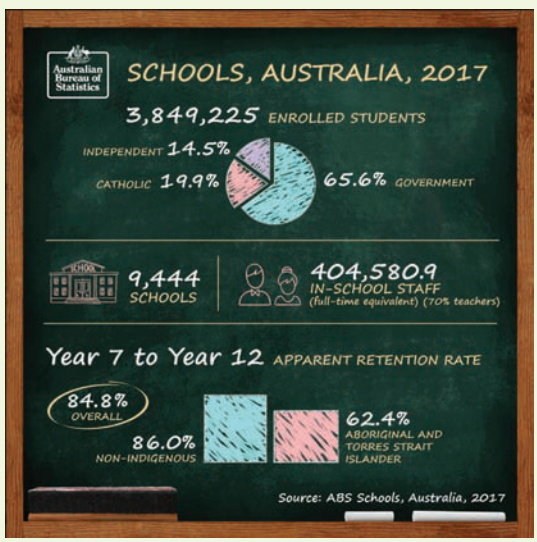


a What is the event start time for a competitor who is 13 years old?

b What is the event start time for a competitor aged 16 years?

c Andrea's event starts at 11 a.m. How old could she be?

4 Information regarding schools in Australia in 2017 is shown.



a What percentage of students attended government schools?

b What percentage of students attended independent schools?

c What percentage of students attended Catholic schools?

d What percentage of non-Indigenous students stayed in school from Year 7 to Year 12?

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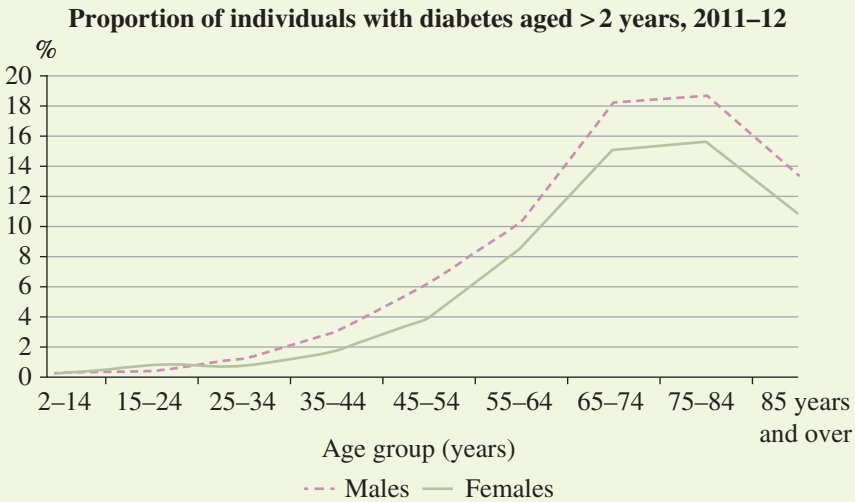
5 The chart shows the proportion of people with diabetes in Australia between 2011 and 2012.



a Approximately what percentage of males aged between 45 and 54 years had diabetes during 2011–12?

b Approximately what percentage of females aged between 65 and 74 years had diabetes during 2011–12?

c Which age group had the highest proportion of people with diabetes during 2011–12?

d Using the information in the graph, were males or females more likely to have diabetes during 2011–12? Justify your answer.

6 A carpenter is trying to decide whether to replace his circular saw or his nail gun, as he can currently afford to replace only one. He keeps records over 3 weeks of how many times he uses each tool for specific jobs. The results are shown in the two-way table.

	Circular saw	Nail gun	Total
Week 1	7	6	13
Week 2	3	12	15
Week 3	9	3	12
Total	19	21	40

a How many times does the carpenter use his circular saw in Week 3?

b How many times does the carpenter use his nail gun in Week 1?

c What percentage of Week 2 does the carpenter use his nail gun?

d In total, what percentage of the 3 weeks does the carpenter use his circular saw?

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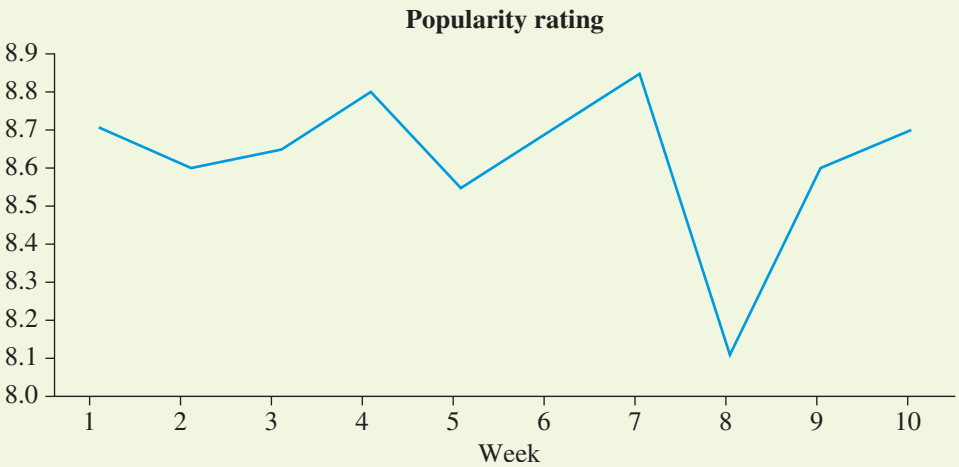
Complex Familiar

7 The popularity rating of a politician running for Prime Minister over a period of 10 weeks is shown.

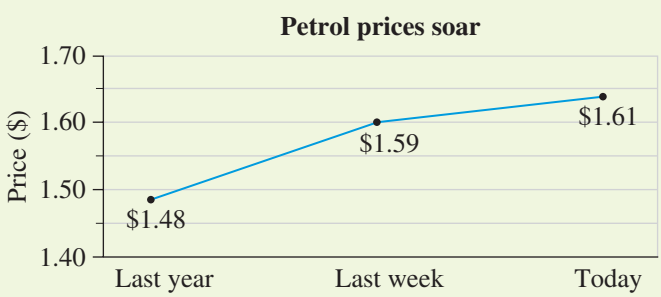


a What conclusions can the reader make from this graph?
b Identify and interpret some of the features that make this a misleading graph.
c Give some reasons why this graph might have been produced to look the way that it does.

Complex Unfamiliar

8 Interpret each of the following graphs and any accompanying text.
i Summarise the information provided by the graph.
ii What aspects of this graph might mislead a reader?
iii List the changes that should be made to make the graph and its title more accurate.

a



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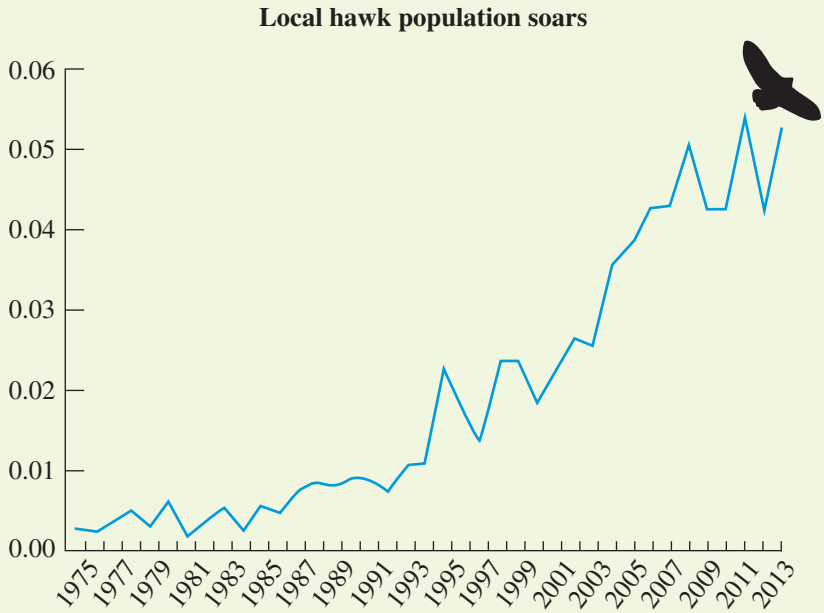
b



9 Interpret the given table.

a Describe in a few words what the table shows.

b Which month and year had the highest number of visitors?

c Which month and year had the lowest number of visitors?

Short-term visitors to Australia

	2015	2016
Jan	303 800	546 200
Feb	319 100	722 200
Mar	313 500	674 500
Apr	294 200	551 400
May	244 800	483 000
Jun	261 400	488 300
Jul	329 700	627 100
Aug	304 900	573 800
Sep	268 600	571 500
Oct	320 700	624 000
Nov	342 900	668 900
Dec	422 300	897 700

Source: ABS 3401.0 - Overseas Arrivals and Departures, Australia, Feb 2016

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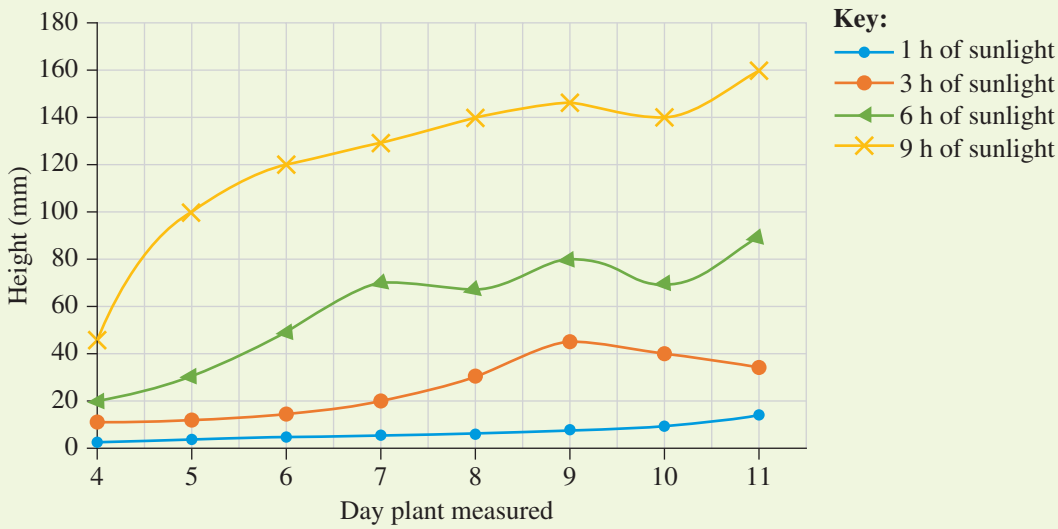
10 Interpret the graph, answering the following questions.



a Describe the experiment that was carried out, according to the graph.

b Did the plants grow at a constant rate (i.e. by the same amount or proportion each day)? If not, in which amount of sunlight was the fastest growth recorded?

c According to this experiment, which amount of sunlight is best for plant growth?

d What improvements would you suggest to the graph, if any?

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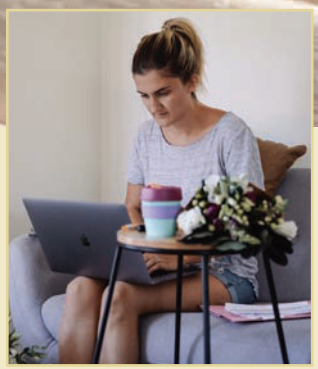
6 Drawing Graphs



Maths for a business owner: Emily Richardson

Emily Richardson works from her home running two businesses: one with her husband in wedding videography and one in floristry.

Tell us a bit about your job. What does a typical day look like?

A typical day starts with an early morning trip to the flower market, then I go home to make up the bunches and send them on their way to be delivered. After that the administration side of my day begins. This includes processing payments and orders, inputting any receipts and expenses I have accumulated into a spreadsheet, and replying to emails.

What maths did you study at school?

At school I did study a lot of maths, as originally I wanted to work in a medical field. However, after two different university degrees, I could not find satisfaction in my work choices. I gave them all away and now enjoy being my own boss.

How do you use maths in your job? Could you give some examples?

I do a lot of calculations in creating quotes for clients. I create graphs and formulas (equations) in spreadsheets, as being a business owner I have to organise tax and invoices.

I work on tasks such as increasing and decreasing mark-ups and discounts, calculating tax, budgeting, and superannuation. This means working with ratios, fractions and percentages, and I have to decide on the best technology to produce graphs, spreadsheets, step and column graphs, and pie and picture graphs.

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In this chapter

6A Determining the best graph for a dataset

6B Using spreadsheets for tables and graphs **[complex]**

6C Graphing continuous change **[complex]**

Problem-solving and modelling task

Puzzle

Chapter Checklist

Chapter Review

Syllabus reference

Unit 1 Topic 3 Drawing graphs (9 hours)

In this subtopic, students will:

- determine which type of graph is best for displaying a dataset
- use spreadsheets to tabulate and graph data **[complex]**
- draw a line graph to represent any data that demonstrates a continuous change, such as hourly temperature **[complex]**.

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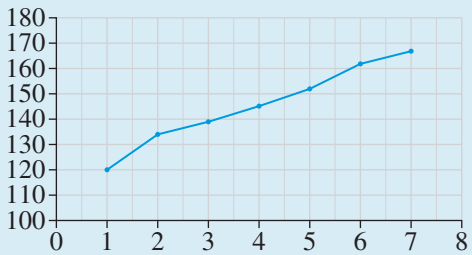
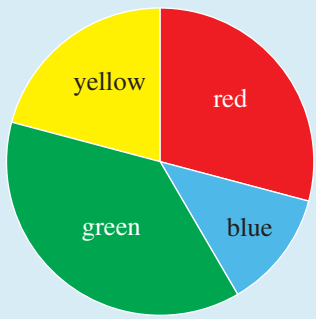
Pre-test

1 Label the following diagrams according to the type of graph or table they are, choosing from: pie graph, column graph, two-way table, line graph, histogram, dot plot and stem-and-leaf diagram.

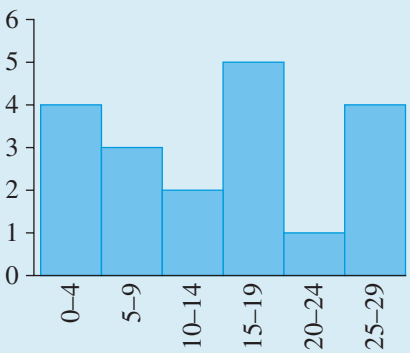
a



b



c



d

Stem	Leaf
1	0 4
2	2 6 7 9 9
3	2 3 4 7
4	1 1 7 9
5	2 6
6	8 8

2 The data of a survey that was carried out is shown.

Letter	A	E	I	O	U
Frequency	14	10	11	7	13

a What is the frequency for the letter A?

b What is the frequency for the letter O?

c Hand draw a column graph of this data, with 'Letter' on the horizontal axis and 'Frequency' on the vertical axis.

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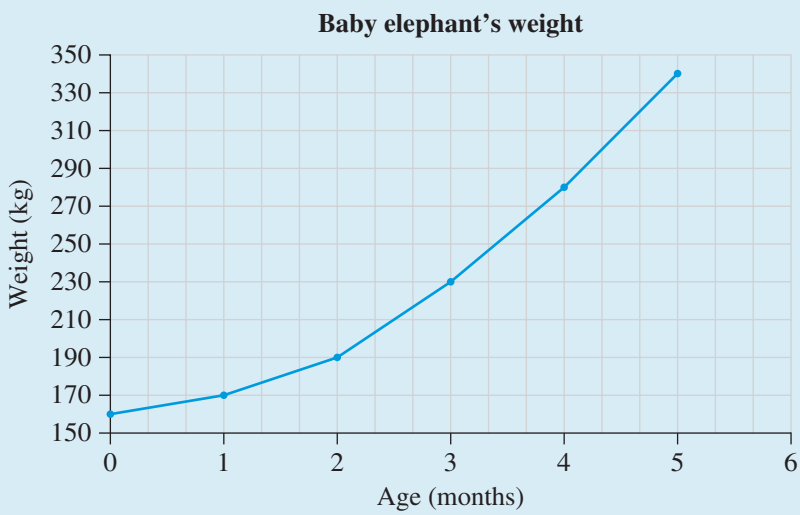
3 A group of young adults were asked what State or Territory they were born in. The responses are shown. Copy and complete the following, to tabulate the data.

Vic.	Qld	ACT	Qld	NSW	NSW
Qld	Qld	Vic.	SA	Qld	SA
WA	Vic.	NSW	Vic.	Qld	Tas.
SA	Qld	Qld	SA	WA	Qld
WA	NSW	Qld	Qld	Qld	Qld
Qld	Qld	Vic.	WA	NT	Vic.
SA	NSW	Qld	WA	NT	Qld

State	Frequency
NSW	5
Qld	
Vic.	
SA	
WA	
NT	
ACT	
Tas.	

4 The following is a graph of the weight of an elephant for the first 5 months of its life.



a How much did the elephant weigh at 1 month?
b How much did the elephant weigh at 3 months?
c How much did the elephant weigh at 4 months?

A link to a HOTmaths lesson is provided in the Interactive Textbook to revise this topic.

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6A Determining the best graph for a dataset

LEARNING GOAL

- Determine which type of graph is best for displaying a dataset.

Why is determining the best graph for a dataset essential?

At some point throughout your career, you may be asked to present some collected data to other people for them to interpret. Deciding how information should be presented can be a daunting task. You may ask yourself, 'What are the important features? How can this be presented visually to best summarise the information easily?' Because of this it is essential to understand how to choose the best graph, depending on what data you are trying to present.

Choosing the right graph is essential to correctly presenting information.

WHAT YOU NEED TO KNOW

- A **dataset** is a collection of related sets of information.
- Types of data:
  - **Categorical data** is the type where the responses are not numbers; for example, the types of livestock a farmer cares for.
  - **Numerical data** is the type where the responses are numbers; for example, the temperature of water in a hot water boiler.
  - **Discrete data** is numerical data where the responses are whole numbers; for example, the number of screws required to build a timber frame for a house.
  - **Continuous data** is numerical data that can take any value including fractions and decimals, usually a measurement; for example, the weight of a newborn baby.

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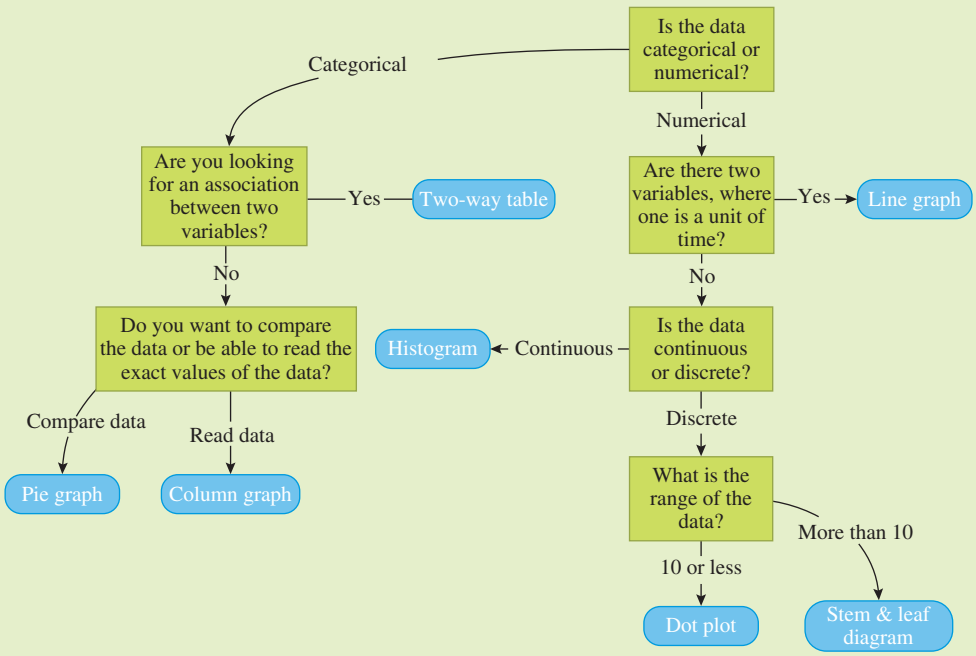
- In order to decide what graph to use, follow the flow diagram below, based on the types of data being used.



Example 1 Selecting and drawing a pie graph

James works as a graphic designer for a town council. He is given the task to produce a display of household water usage to be used in a TV advertisement promoting ways of saving water.

Household water usage	
Home area	**Percentage of water use**
Kitchen	20%
Laundry	18%
Toilet	22%
Bathroom	40%

a What features of a pie graph make it suitable for a quick comparison of data?

b Calculate the pie graph angle for each of the listed household water use areas. Round each angle to the nearest whole number.

c Draw a pie graph showing household water usage.

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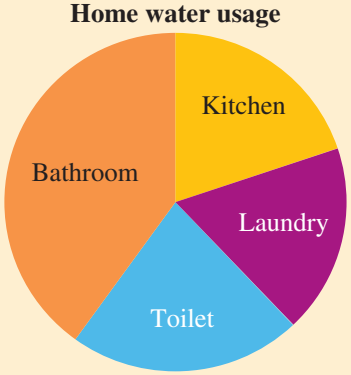
WORKING	THINKING
a James would use a pie graph, as it is colourful and attracts attention; it arranges information quickly; it gives a visual comparison of each part's proportion of the total.	*What is James wanting to show?* A TV advertisement that can arrange information quickly and simply.
b	*What type of dataset is this?* A visual comparison of water usage as a proportion of the total household consumption. *Which type of graph best suits arranging particular parts in relation to the whole?* The graph that best suits this data is a pie graph. Add a third column to the table. Each angle = % × 360° Laundry angle $= \frac{18}{100} \times 360 = 64.8$ $= 65°$
c	Draw a circle and mark the angles using a protractor and ruler. Colour and label the sectors and write the title.

Home water usage		
Home area	**Percentage**	**Angle**
Kitchen	20%	72°
Laundry	18%	65°
Toilet	22%	79°
Bathroom	40%	144°



Example 2 Identify varying characteristic of datasets

Simon is asked to record how Bowen's average high temperature varies from month to month for 2018, in a report to his management, to see if it can validate purchasing an air conditioner.

Jan 30, Feb 28, March 27, April 25, May 25, June 20, July 19, August 20, September 22, October 25, November 27, December 29

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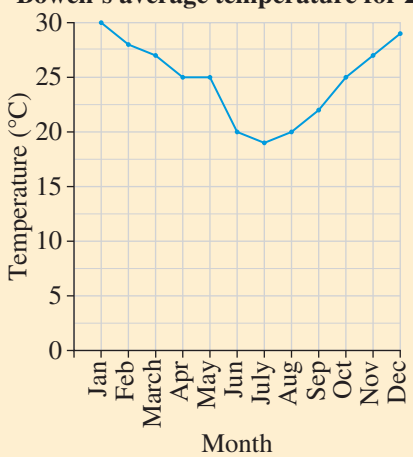
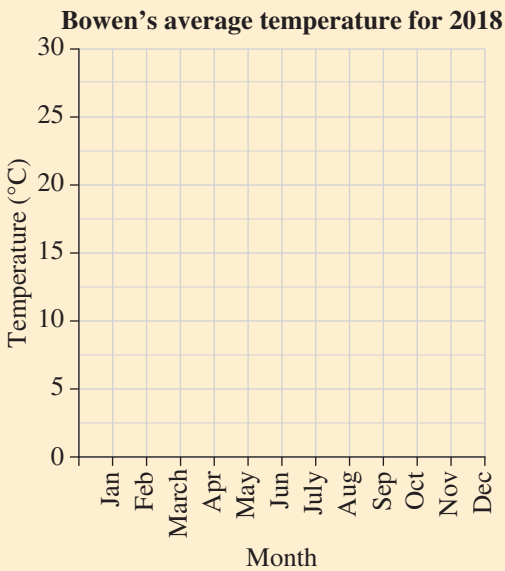
a What type of graph will best suit Simon's project?
b Draw the graph.

WORKING	THINKING
a Line graphs are best used to compare changes over the same period of time for more than one group.	*What is Simon wanting to show?* The variation in weather. *What type of dataset is this?* It is comparing varying temperatures. *Which type of graph best suits comparing and varying data?* The graph that best suits this data is a line graph.
b **Bowen's average temperature for 2018**  	It is best to use graph paper when drawing a line graph.  Give your graph a title. Write labels for the vertical axis: Temperature (°C), in intervals of 5. Write labels for the horizontal axis: Month, writing the months of the year. Find each month's temperature and put a dot at the correct location.

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Exercise 6A

FUNDAMENTALS

1 Olivia is setting up a children's afterschool program. She has recently completed a survey of school-aged children, asking them what is their favourite activity. Olivia plans to include this information in her advertising flyer. The survey results are: Dance = 30, Music = 40, Art = 25, Cricket = 20, Football = 35.

a What type of graph should Olivia use?
b Explain why she should use this graph.
c Draw the graph.

Hint Use WYNTK and the examples to help you.

2 For each of the following, determine which type of graph would be best for displaying the dataset. Keep in mind there may be more than one possible answer.

a

Time	8 a.m.	9 a.m.	10 a.m.	11 a.m.	12 p.m.	1 p.m.
y	13	17	16	18	18	20

b

A	B	B	D	D
D	C	B	A	C
A	A	A	C	A
D	A	D	B	C

3 Sonia is recording rainfall to assist with her gardening project. She needs to include a visual component.

Jan 124 mm, Feb 70 mm, March 50 mm, April 48 mm, May 98 mm, June 210 mm, July 202 mm, August 185 mm, September 250 mm, October 252 mm, November 194 mm, December 160 mm

a What type of graph should Sonia use?
b Explain why she should use this graph.
c Draw the graph.

Hint How would this particular graph best display the information?

APPLICATIONS

SF: 4–9 | CF: – | CU: –

Example 1 ★**4** Jeff works at the Queensland Zoo and has been given a list of how many snakes there are in other zoos in the area. He has been asked to plot a dataset, shown in the table on the next page, of how many snakes there are in the 15 local zoos.

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20	28	46	30	32
41	26	42	36	28
36	38	46	37	38

a What type of graph should Jeff use?
b Explain why he should use this graph.
c Draw the graph.

Hint Think about what type of data this is.

Example 2 ★5 As part of Brandon's role as an electrician, he must drive to clients' homes to provide quotes for jobs. As this is part of his job, he is able to claim some expenses on tax, such as petrol. His accountant has asked him to keep track of how far he travels each day for a month, in order to predict how much he will be able to claim at the end of the financial year. The distances driven each day by Brandon, for 30 days, can be seen in the following table.

28.1 km	31.3 km	21.2 km	17 km	13.8 km	21.3 km
26.4 km	5.2 km	5.8 km	8.9 km	27.5 km	24.8 km
22.4 km	7.6 km	31.1 km	7.7 km	20.9 km	12.3 km
13.6 km	14.4 km	23.1 km	9.5 km	12 km	15.5 km
8 km	22.6 km	12.8 km	22.5 km	27.7 km	11 km

a What type of graph should Brandon use?
b Explain why he should use this graph.
c Draw the graph.

★6 Brett works for an online car sales company and has been given datasets of sales and prices for various makes of cars. He has been asked to give a visual representation of the data.

Make	Sales	Transaction price
Australian Honda	150000	$27500
Fiat Chrysler	220000	$35000
Ford Motor Company	235000	$36500
General Motors	280000	$38000
Nissan Australia	130000	$25000
Toyota Motor Company	245000	$32500
Volkswagen Group	50000	$40500

a What type of graph should Brett use?
b Explain why he should use this graph
c Draw the graph.

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★7 At a miners' union meeting, people are asked what is being mined at the mine site where they work, choosing from minerals, petroleum, natural gas or other. The results are shown in the table.

natural gas	petroleum	natural gas	minerals	petroleum
minerals	minerals	natural gas	other	other
natural gas	natural gas	other	minerals	other

a What type of graph should be used in order to read exactly how many people gave each response?
b Explain why you would use this graph.
c Draw the graph.

★8 Henriette is helping out at a newspaper for her school's work experience program and has been given some data. She has been asked to give a visual representation of the data.

Males aiming for a High School Certificate = 16
Males aiming to go to TAFE = 46
Total amount of males recorded = 65
Females aiming to go to TAFE = 51
Females aiming for an apprenticeship = 3
Total aiming for a High School Certificate = 28
Total aiming for an apprenticeship = 6

a What type of graph should Henriette use?
b Explain why she should use this graph.
c Draw the graph.

★9 A farmer is concerned with the health of one of her cows, which is pregnant. The vet suggests that she keep a record of the cow's weight during the pregnancy. The farmer weighs the cow at the beginning of each month during the pregnancy. The results are given below.

Month	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Weight (kg)	710	717	725	730	738	745	752	762	771	775

a What type of graph should the farmer use?
b Explain why she should use this graph.
c Draw the graph.

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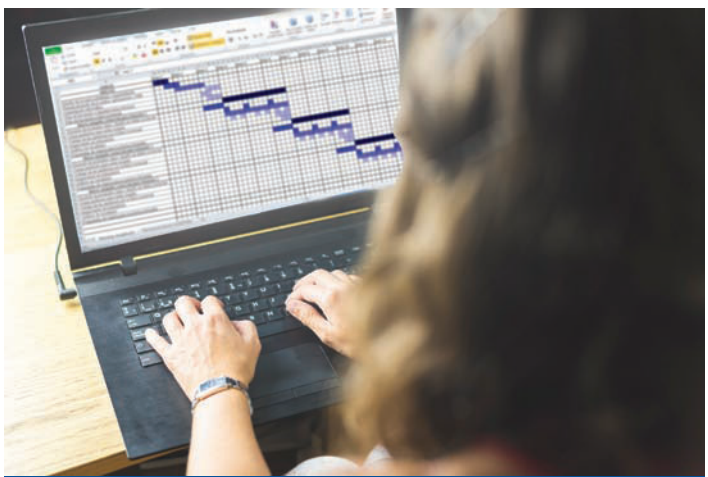
6B Using spreadsheets for tables and graphs COMPLEX

LEARNING GOALS

- Tabulate data using a spreadsheet
- Graph data using a spreadsheet

Why is using spreadsheets for tables and graphs essential?

After it has been determined what is the best graph for displaying a dataset, the data then needs to be entered into a table, using a spreadsheet. This will allow the user to then graph this data using the spreadsheet, adjusting and modifying it to suit the information's purpose. It is very common that data may be added to or even altered at times. Using a spreadsheet is essential because it allows for these kinds of changes to be made easily, and any graphs are then updated automatically.



Using a spreadsheet allows changes to be made easily to your data

WHAT YOU NEED TO KNOW

- When inputting data into a spreadsheet, the format of the cell can be of significance.
  - Check that the 'Format' of the cell is what you desire.
- When graphing data from a spreadsheet, remember to select a graph that has been assessed as being the best graph for a dataset.

***Note:** A guide to spreadsheets is provided as an online appendix in the interactive textbook.*

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Example 3 Tabulating data using a spreadsheet

A group of accountants were asked which of their roles takes the most time, choosing from conducting financial investigations, preparing reports and undertaking audits. The responses of this questionnaire are shown below.

conducting financial investigations	preparing reports
undertaking audits	conducting financial investigations
undertaking audits	conducting financial investigations
conducting financial investigations	undertaking audits
conducting financial investigations	conducting financial investigations
undertaking audits	undertaking audits
preparing reports	conducting financial investigations
conducting financial investigations	undertaking audits

Tabulate this data using a spreadsheet.

WORKING

	A	B
1	**Accountant's role**	**Frequency**
2	Conducting financial investigations	8
3	Preparing reports	2
4	Undertaking audits	6

THINKING

Within a spreadsheet, create three row headings: 'Conducting financial investigations', 'Preparing reports' and 'Undertaking audits'.

Title these roles as 'Accountant's role'.

Title the column next to it as 'Frequency' (i.e. the number of responses).

Count how many there are of each response and write the number in the table.

Format the table by considering borders, shading, text alignment, font, text size, etc.

Example 4 Graphing data using a spreadsheet

Alix is asked to create a graph that shows the most frequent age group of her company's customers. Graph this data on a histogram, using a spreadsheet.

Age group	Tally	Frequency
13–16	𝍸 III	8
17–20	𝍸 𝍸	10
21–24	𝍸 IIII	9
25–28	𝍸	5
29–32	𝍸 III	8

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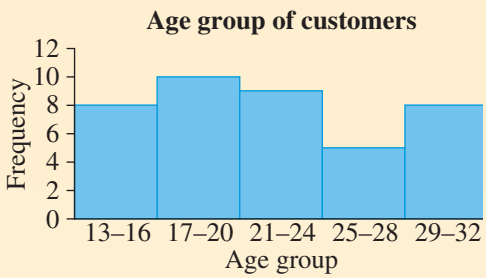
WORKING

	A	B
1	Age group	Frequency
2	13-16	8
3	17-20	10
4	21-24	9
5	25-28	5
6	29-32	8



THINKING

Insert all the age groups and their frequencies into two columns.

Select the data and choose to insert a chart.

Choose a histogram from the given options.

Alter the chart as required. The 'bin width', which can be found under 'axis options', may need to be changed to a value of 5.

Add elements to the chart, such as a 'Chart title' and 'Axis titles'.

Exercise 6B

FUNDAMENTALS

1 Tabulate the following sets of data, using a spreadsheet.

Hint Use WYNTK and the examples to help you.

a

red	green	blue	red	green
blue	red	green	red	green
blue	red	green	green	green

b

agree	neutral	strongly agree	strongly disagree
strongly agree	agree	strongly disagree	agree
strongly agree	agree	disagree	agree
neutral	disagree	disagree	agree

XLS

2 Graph the following data as a column graph, using a spreadsheet.

Section	Frequency
A	12
B	9
C	17

Hint For help, see the online guide to spreadsheets in the Interactive Textbook.

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APPLICATIONS

SF: – | CF: 3–6, 8 | CU: 7

Example 4 ★3 A report has shown the following information relating to Australian Greenhouse Gas Emissions by Economic Sector, in 2018. Use the information to draw a pie graph, using a spreadsheet.

Economic sector	Percentage
Agriculture	9%
Transportation	27%
Commercial & Residential	12%
Electricity	29%
Industry	23%

Example 3 ★4 During an international flight, a flight attendant walks through the plane and surveys a selection of passengers about which meal they would prefer, choosing from chicken, beef and vegetarian. The survey's responses, which are shown below, are to be presented to the airline's catering company.

chicken	chicken	vegetarian	chicken	chicken	chicken
vegetarian	chicken	beef	beef	beef	vegetarian
vegetarian	beef	vegetarian	chicken		

a What type of graph should the flight attendant use to present the data?
b Explain why the attendant should use this graph.
c Draw the graph.

★5 Emilia is preparing for a fitness competition and has been asked by her trainer to create a poster of how she spends her training time, including a visual representation of her data.
Emilia has calculated that she spends her training time in the following ways.

Cardio = 55%
Weights = 30%
Food preparation = 6%
Stance practice = 9%

a What type of graph should Emilia use?
b Explain why she should use this graph.
c Draw the graph.

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XLS ★6 The table shows the number of young people aged 16–24 years with an anxiety disorder.

a Graph the data as a pie graph, using a spreadsheet.

b From the graph, which anxiety disorder is the most common in this age group?

Anxiety disorder	Number of young people
Panic disorder	55 700
Agoraphobia	71 600
Social phobia	138 300
Generalised anxiety disorder	195 300
Obsessive-compulsive disorder	56 300
Post-traumatic stress disorder	34 300

XLS ★7 Samantha is planning a holiday and is trying to save some money. At the start of each week she writes down how much money she has saved. Her results are presented in the table.

Week	1	2	3	4	5	6	7	8	9
Money saved ($)	45	52	63	77	88	103	126	158	188

a Graph the data as a column graph, using a spreadsheet.

b If Samantha needs to save $200 by Week 10 for her holiday, does your graph suggest she would be able to achieve this? Justify your answer.

★8 Zaran is collecting information for his new business. He has recently completed a survey of customers, asking them what their main reason was for using social media. Zaran plans to include this information in his advertising flyer.

a What type of graph should Zaran use?

b Explain why he should use this graph.

c Draw the graph.

Reason	Frequency
Chat/Send messages	79
Watch videos	57
Listen to music	48
Check up on friends	36
Update status	31
Follow influencers	29
Work/study	33
Comment on the news	20
Play games	35
Follow a brand	27
Meet new people	35
Participate in contests	10
Comment on products	2
Buy/Sell	45
Contact customer service	3

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6C Graphing continuous change COMPLEX

LEARNING GOALS

- Draw a line graph by hand to display data that demonstrates a continuous change
- Draw a line graph using a spreadsheet, to display data that demonstrates a continuous change

Why is graphing continuous change essential?

In many instances, things will change continuously over time. Examples include weight, temperature, distance of a moving object from its start and the public popularity of political figures. If we want to understand these changes, it is essential to be able to graph these relationships so we are then able to analyse and interpret them. This may then allow us to make certain predictions.

A plumbing technician using a digital tablet and camera to check the efficiency of a hotel's hot water supply in a boiler room

WHAT YOU NEED TO KNOW

- In a line graph of change over time the ***x*-axis** represents time (e.g. a date or time elapsed from the start).
- The ***y*-axis** has a scale and indicates the measurement, (e.g. weight, temperature, distance, popularity survey results).
- A number of **data series** can be plotted in the same graph on the same axes, and this is particularly useful for analysing and comparing the **trends** in different datasets.

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Example 5 Drawing a line graph by hand to display continuous change

Over a 1 year period, Charlotte took note of how many kilometres she was able to drive in her car on a full tank of petrol, on average, for each month. Her results are shown in the table.

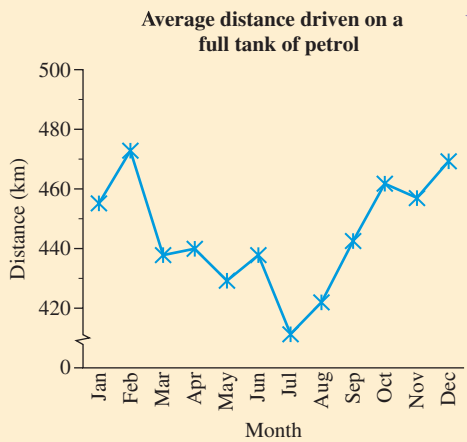
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Distance (km)	455	473	438	440	429	438	411	422	443	462	457	470

a Construct a line graph by hand of the data collected.

b Describe the change over time shown by the graph.

WORKING

a



b Charlotte's car travels further on a full tank of petrol during the warmer summer months. The colder the month, the less far it travels.

THINKING

Label the months on the horizontal axis, and label the distance driven, in kilometres, on the vertical axis.

Mark an × at each data point.

Join up the data points with straight lines.

Be sure to use a ruler when drawing straight lines.

It can be seen that the number of kilometres travelled on a full tank of petrol goes down during the colder months.

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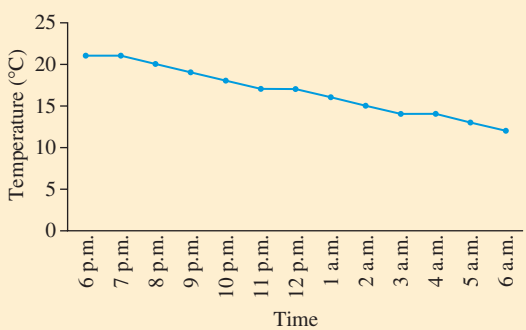
Example 6 Drawing a line graph using a spreadsheet, to display continuous change

Create a line graph of this data, using technology of your choice. Here we will use a spreadsheet.

Time	Temperature (°C)
6 p.m.	21
7 p.m.	21
8 p.m.	20
9 p.m.	19
10 p.m.	18
11 p.m.	17
12 a.m.	17
1 a.m.	16
2 a.m.	15
3 a.m.	14
4 a.m.	14
5 a.m.	13
6 a.m.	12

WORKING



THINKING

Input the data into a spreadsheet.

Select the data and choose to insert a chart.

Choose an appropriate chart from the options given.

Add elements to the chart, such as a 'Chart title' and 'Axis titles'.

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Exercise 6C

FUNDAMENTALS

1 The table shows the data between two variables, x and y.

x	1	2	3	4	5
y	4	7	6	9	11

a When x is 2, what is the value of y?
b When x is 5, what is the value of y?
c Hand draw a line graph of the data collected, with x on the horizontal axis and y on the vertical axis.

Hint Find the number 2, then see which number corresponds in the y row.

2 For each of the following, use technology of your choice to create a line graph of the data.

a

Year	Temperature (°C)
Jan	35°C
Feb	32°C
March	30°C
April	27°C
May	23°C
June	15°C
July	5°C
August	10°C
Sept	20°C
Oct	23°C
Nov	28°C
Dec	30°C

b

x	1	2	3	4	5	6	7
y	231	263	288	294	344	351	374

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APPLICATIONS

SF: – | CF: 3–5 | CU: 6–7

Example 5 ★3 The average rainfall per month in Ipswich is presented in the table.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average rainfall (mm)	119	101	107	58	155	110	32	55	36	68	194	88

a Hand draw a line graph of this data with the month on the horizontal axis and the average rainfall on the vertical axis.

b Describe the change over time shown by the graph.

Hint It always looks best when you use a ruler when drawing straight lines.

Example 6 ★4 Cameron wishes to keep track of his spending habits, so he writes down how much money he spends on food each week for 10 weeks. His results are shown in the table.

XLS

Week	Money spent on food ($)
1	96
2	112
3	65
4	158
5	143
6	88
7	165
8	173
9	92
10	151

a Using technology of your choice, create a line graph of this. Label the week number on the horizontal axis and the money spent on food on the vertical axis.

Hint Use Example 6 to help you.

b Describe the change over time shown by the graph.

★5 The table shows an averaged dataset of males and females who had the flu over a year.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Females	0	0	900	1000	3000	3500	3000	2900	2500	2500	2500	2450
Males	0	0	500	550	2000	2600	2500	2000	1750	1750	1500	1500

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a Hand draw a line graph of this data, showing the month on the horizontal axis and the number of people on the vertical axis. You will end up drawing two lines on the same graph: one for females and one for males.

b Describe the change over time shown by the graph.

Hint Make sure you check which data goes along the vertical axis and which data goes along the horizontal axis.

XLS ★6 A plumbing technician is assessing the efficiency of a hot water boiler system in an apartment complex. She takes the following water temperature measurements, in degrees Celsius, over a 20 minute period.

Time	10:11	10:12	10:13	10:14	10:15	10:16	10:17	10:18	10:19
Temperature of water (°C)	61.0	61.5	62.0	61.0	62.5	63.5	61.0	60.5	62.5

Time	10:20	10:21	10:22	10:23	10:24	10:25	10:26	10:27	10:28
Temperature of water (°C)	61.0	60.0	59.5	61.0	63.0	60.5	62.0	59.5	61.5

a Using technology of your choice, create a line graph of this data. Label the time on the horizontal axis and the temperature on the vertical axis.

b A hot water boiling system is said to be working efficiently when it is able to maintain water at 63°C and vary by only 2°C. What conclusions can be made from the graph about the hot water boiling system?

Hint Try using different technology for each dataset to give you practice.

XLS ★7 The table shows a dataset of global water use, in gigalitres, by sectors.

Year	Agriculture (GL)	Industrial use (GL)	Domestic use (GL)
1960	550	100	100
1970	650	150	140
1980	990	170	150
1990	1700	400	140
2000	2200	500	200
2010	3000	1100	400

a Using technology of your choice, create a line graph of this data. Label the year on the horizontal axis and water use (in GL) on the vertical axis.

b What conclusions can be made about water usage in the agricultural, industrial and domestic sectors?

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Problem-solving and modelling task

DRAWING GRAPHS

Background: Graphs are useful for comparing data, and pie charts are particularly useful for comparing the parts of a whole.

Task: You want to save up to buy a game (or other item) and you need to analyse your spending to see where you can save. Choose a a game or item that costs considerably more than the amount you usually save per month.

To complete this task, follow the problem-solving workflow diagram below and use the steps listed as a guide.

Stage 1: Formulate

1 Establish what your current regular monthly income is in total, and the amount you need to save to buy the game (or other item).

2 Determine all your current regular monthly expenses are. They must be the same as or less than monthly income (otherwise they would not be 'regular'). If less, this is your current monthly savings.

Stage 2: Solve

3 Create a pie graph of your monthly expenses, using Excel, with income as your total and include monthly savings even if they are zero.

4 Create a second pie graph of your ideal monthly expenses – your target budget. Work out which particular expenses you can reduce, and see how you can maximise your monthly savings. Compare the pie graphs for regular expenses and target budget to see if the latter is realistic and achievable.

5 Work out how long it will take to buy the game.

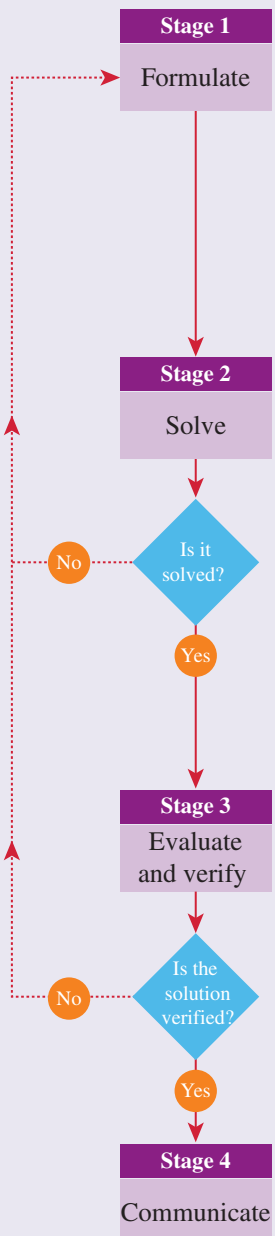
Stage 3: Evaluate and verify

6 Is your target budget realistic and achievable?

7 Will it allow you to save up enough to buy the game in a reasonable amount of time?

Stage 4: Communicate

8 Write a report that explains (compared to your current expenses), which expenses you will reduce, how much you will save per month, and how long it will take to buy the game.



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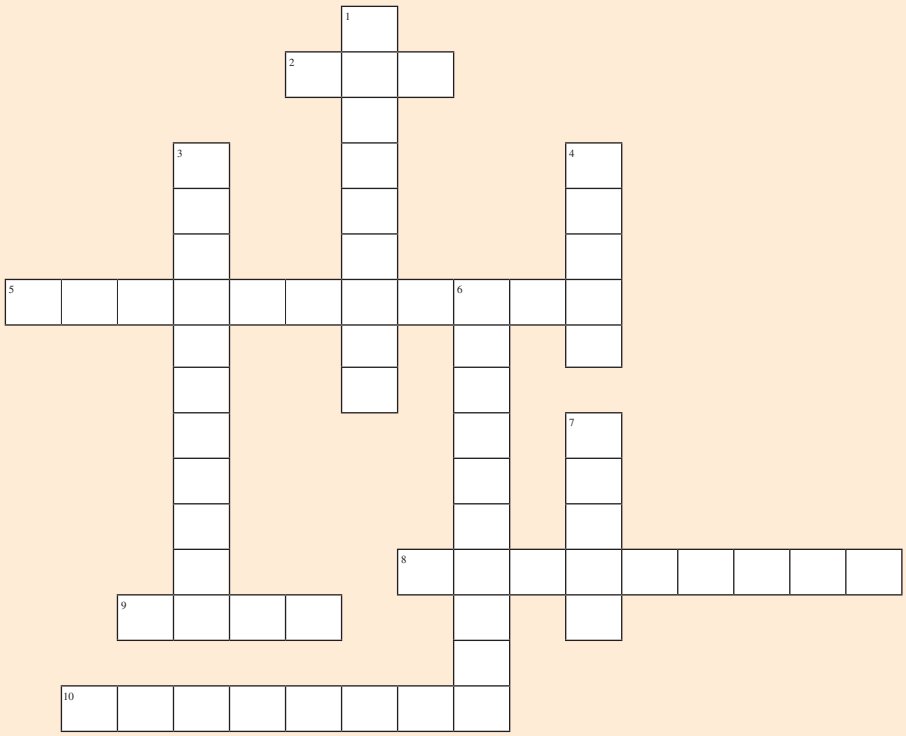
Puzzle



Across

2 Categorical data, where the user wishes to compare the values of the categories, should be displayed as a _____ graph.

5 Profession, such as plumber or nurse, is an example of _____ data.

8 Number of tools owned is an example of _____ data.

9 Numerical data that is discrete, where the range is more than 10, should be displayed as a _____-and-leaf diagram.

10 When using technology, features such as the chart title, axes labels or scales are know as _____ of the graph.

Down

1 Numerical data that is continuous should be displayed as a _____.

3 Data can be tabulated in a _____ using technology.

4 Discrete data is numerical data where the responses are _____ numbers.

6 _____ data is numerical data that can take any value, usually a measurement.

7 When joining lines by hand, always use a _____.

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Chapter checklist

☐ I can determine which type of graph is best for displaying a dataset.

1 Given the responses below to a survey, determine which type of graph would be best for displaying the dataset.

agree	neutral	disagree	agree	strongly disagree
strongly agree	neutral	disagree	strongly disagree	agree
disagree	strongly disagree	agree	disagree	strongly disagree
disagree	strongly agree	strongly disagree	strongly disagree	strongly disagree

☐ I can tabulate data using a spreadsheet.

2 Given the responses below to a survey, tabulate this data using a spreadsheet.

agree	neutral	disagree	agree	strongly disagree
strongly agree	neutral	disagree	strongly disagree	agree
disagree	strongly disagree	agree	disagree	strongly disagree
disagree	strongly agree	strongly disagree	strongly disagree	strongly disagree

☐ I can graph data using a spreadsheet.

3 Use the following dataset to create a pie graph using a spreadsheet.
Carly works at a new café and has been asked by the chef to create a graph for the following dataset.

Salad choices

Taco 10% Spinach 17% Garden 13% Chef 25% Caesar 35%

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☐ I can draw a line graph by hand to display a continuous change.

4 Hand draw a line graph of the data presented in the table.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Distance (km)	455	473	438	440	429	438	411	422

Month	Sep	Oct	Nov	Dec
Distance (km)	443	462	457	568

☐ I can draw a line graph that displays continuous change using technology.

5 Create a line graph of the following dataset using technology.
Pepper is currently working at a nursery in Ravensbourne. She has been asked to create a graph showing the following dataset of soil temperatures.

Month	10 cm deep (°C)	20 cm deep (°C)
January	23.6	25.7
February	22.8	24.7
March	21.2	23.0
April	18.1	20.0
May	14.3	16.1
June	11.2	12.8
July	10.0	11.8
August	11.0	12.3
September	14.1	15.9
October	17.9	19.0
November	19.9	21.1
December	21.9	23.9

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Chapter review

All questions in the Chapter Review are assessment-style.

Simple Familiar

1 A group of crop farm workers are asked about what type of crops they work on. Their responses are shown below.

fruit	nuts	nuts	fruit	grains
vegetables	vegetables	fruit	fruit	fruit
grains	vegetables	fruit	nuts	vegetables
fruit	grains	nuts	grains	fruit
vegetables	fruit	grains	fruit	grains

Determine which type of graph would be best for displaying this dataset, if the purpose of collecting the data is to compare the proportion of types of crops being farmed.

2 The heights, in cm, of the members of the Opals basketball team are given.

188	178	170	191	185	172	178	188
178	187	192	165	196	180	185	203

Determine which type of graph would be best for displaying this dataset.

3 The average rainfall per month in Gold Coast is presented in the table.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average rainfall (mm)	170	173	162	66	84	92	38	51	34	79	81	126

a Hand draw a line graph of this data.

b What conclusions can be made from the graph?

4 An infant's length, in cm, is measured at the start of each month after she is born. Her lengths are given in the table.

Age (months)	0	1	2	3	4	5	6	7	8	9	10	11	12
Length (cm)	47	54	57	60	62	64	66	68	69	71	72	74	75

Using technology of your choice, create a line graph of this data. Label the age on the horizontal axis and the length on the vertical axis.

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Complex Familiar

5 A survey is conducted asking how people feel about the redevelopment of a local swimming pool. The responses from the survey are given below.

very positive	positive	positive	positive
neutral	neutral	very positive	very positive
positive	positive	negative	negative
positive	very positive	very positive	positive
neutral	positive	very negative	very negative

Tabulate this data using a spreadsheet.

6 A group of professional tradespeople are asked how many hours they worked in the previous week. The results are shown below.

39	42	35	47	41	33	32
48	39	41	40	50	47	37
39	41	36	39	42	45	33
52	36	44	38	51	47	42
39	37	33	51	38	42	39

Choose an appropriate graph for this data, and graph it using technology of your choice.

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7 Using Graphs

Maths for a sign writer: Daniel Fletcher

Daniel Fletcher is a sign writer. He had a lot of previous jobs before finding his perfect job – being able to use his artistic talents.

Tell us a bit about your job. What does a typical day look like?

These days we mainly make the signs in the workshop, then go out and put them up. I start off by looking through the jobs that I have been given, checking them against the quotes for signs. After that I can start actually making them, first designing them on the computer, then using the machines and equipment that produce them. There are always adjustments that have to be made by hand. I also have to do some paperwork to complete the job and provide the information for invoices to be made up.

I love the artistic side of the job, especially when I get to use my hands rather than working on the computer. I enjoy how every day is different, working with various customers.

What maths did you study at school?

I did not do well in mathematics at school. I was terrible at it. I felt I had the ability, but I chose not to listen at school. I would much rather have been playing sport, as I didn't feel that mathematics was useful. It's only now that I wish I had listened, as there has been a lot of times when I needed those skills.

How do you use maths in your job? Could you give some examples?

Measurements are at the heart of signwriting. I do a lot of work that involves conversions and using graphs. Both metric and imperial units are used in the business, as some customers understand only imperial, so I have to use conversion graphs. I also use ratios, dividing and multiplying, scales, percentages, and using technology.

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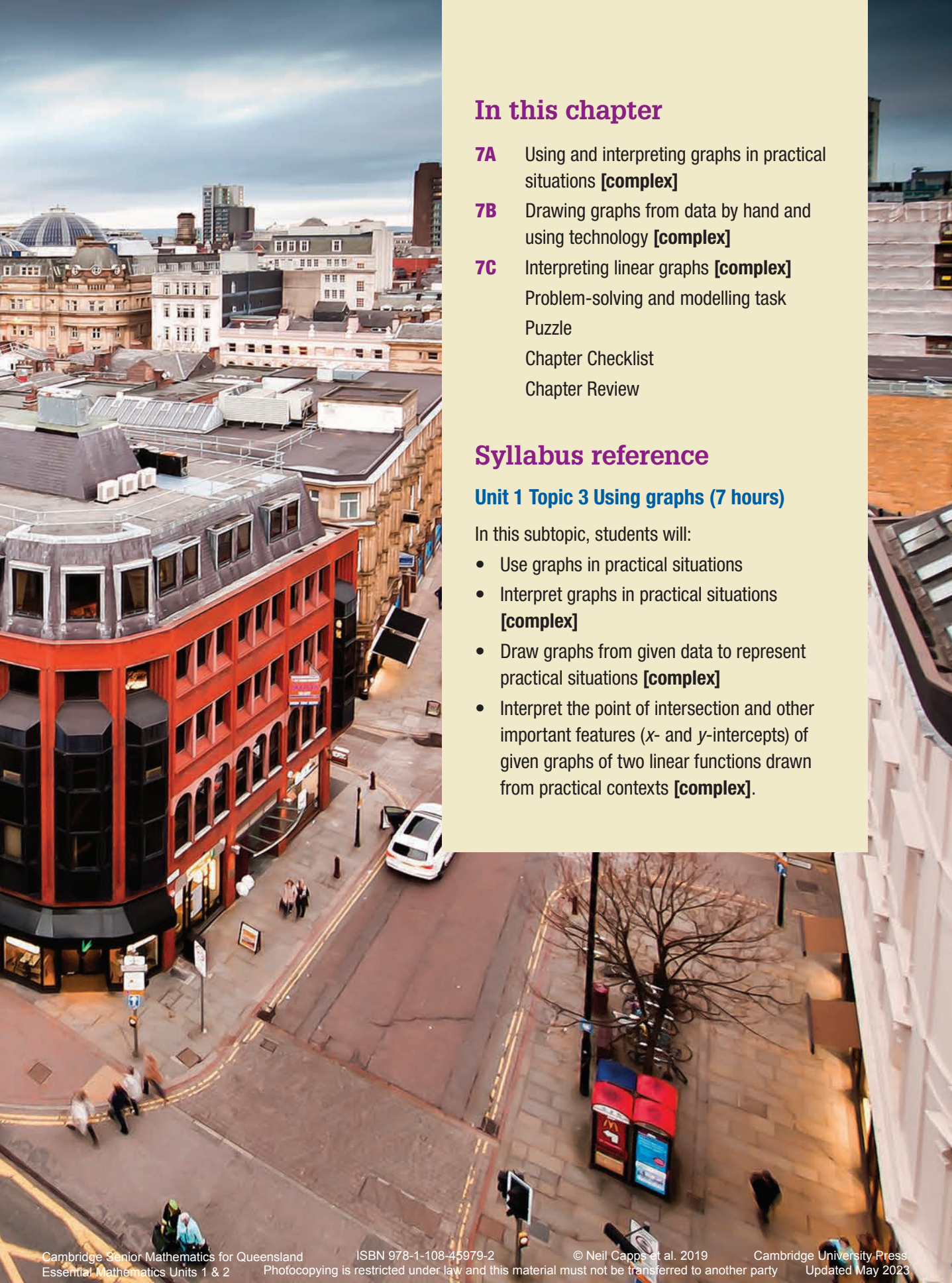

In this chapter

7A Using and interpreting graphs in practical situations **[complex]**

7B Drawing graphs from data by hand and using technology **[complex]**

7C Interpreting linear graphs **[complex]**

Problem-solving and modelling task

Puzzle

Chapter Checklist

Chapter Review

Syllabus reference

Unit 1 Topic 3 Using graphs (7 hours)

In this subtopic, students will:

- Use graphs in practical situations
- Interpret graphs in practical situations **[complex]**
- Draw graphs from given data to represent practical situations **[complex]**
- Interpret the point of intersection and other important features (*x*- and *y*-intercepts) of given graphs of two linear functions drawn from practical contexts **[complex]**.

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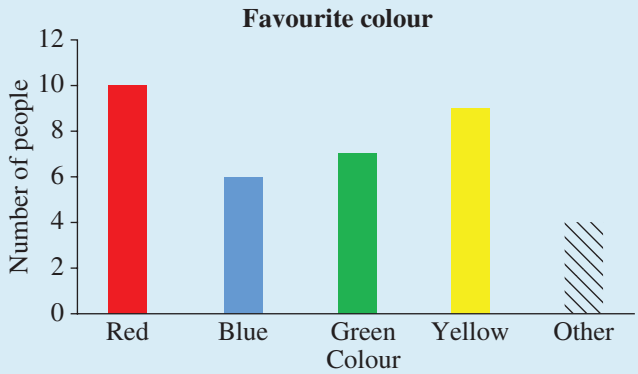
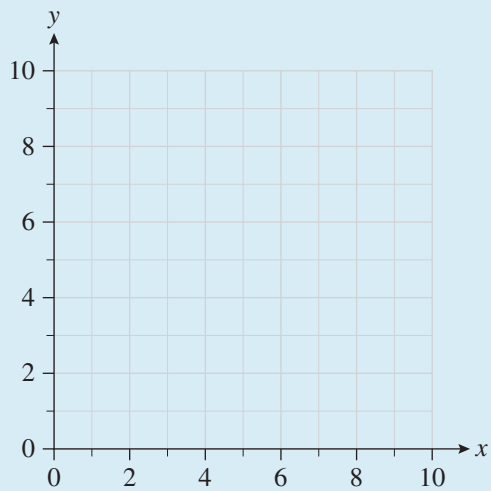
Pre-test

1 The following graph shows the results of a questionnaire asking people what is their favourite colour.



- **a** How many survey participants selected blue?
- **b** How many survey participants selected yellow?
- **c** What is the most popular response?
- **d** What is the difference between the number of people who chose green and the number of people who chose other?

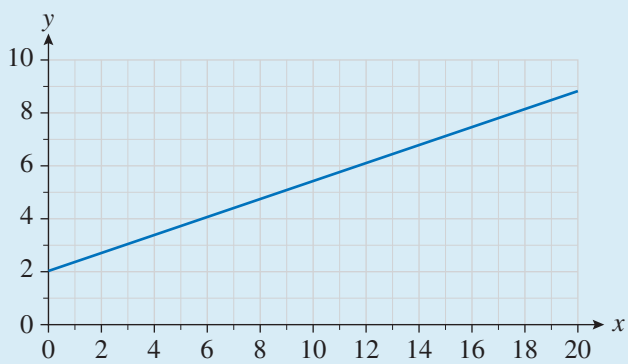
2 Copy the grid to the right into your workbook.



x	1	4	7	8	9
y	3	6	5	7	10

- **a** Plot the following points onto your grid.
- **b** Starting with the point where $x = 1$, join the points together with a ruler.
- **c** What is the value of y when x is equal to 4?
- **d** What is the value of x when y is equal to 7?

3 The graph shows the relationship between the variables x and y.



- **a** What is the value of y when x is equal to 6?
- **b** What is the value of y when x is equal to 15?
- **c** What is the value of x when y is equal to 8?
- **d** What is the value of x when y is equal to 5?

A link to a HOTmaths lesson is provided in the Interactive Textbook to revise this topic.

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7A Using and interpreting graphs in practical situations COMPLEX

LEARNING GOALS

- Use graphs in practical situations (*Note: this part is not complex*)
- Interpret and analyse data from graphs in practical situations

Why is it essential to know how to use and interpret graphs in practical situations?

There will be many times throughout your working career when you will encounter a graph. It could be when interpreting the relationship between voltage and current as an electrician; figuring out the tax to be paid on someone's income; estimating the value of a piece of machinery after a certain number of years; or reading off an expected height for a given weight. In any situation, being able to interpret graphs and knowing how to use them is an essential skill.

Understanding how to use and interpret graphs is in your hands.

WHAT YOU NEED TO KNOW

- How to read and interpret graphs form Chapter 5, sections 5A to 5C.

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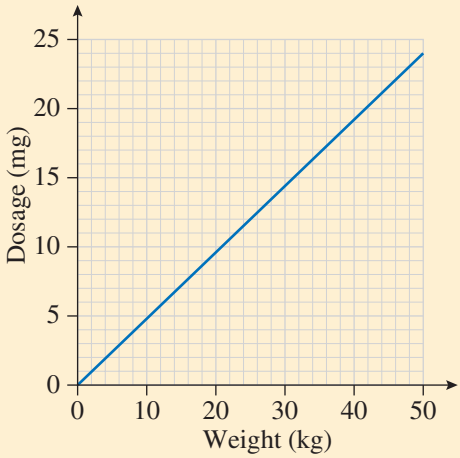
Example 1 Using a graph in a practical situation

Bruno works as a veterinarian assistant. In order to determine the amount of Valium required to give a dog suffering from anxiety, he uses the following graph.

a How much Valium should Bruno give a dog that weighs 10 kg?

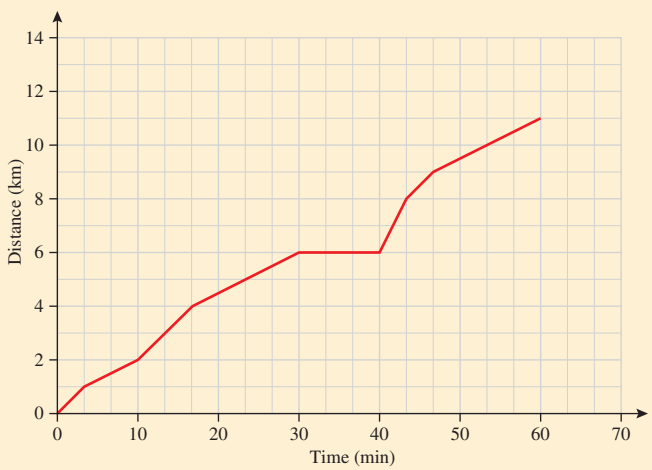
b If Bruno gives 17 mg of Valium to a dog, determine the weight of the dog (assuming Bruno gave the correct dosage).



WORKING	THINKING
a 5 mg	Find 10 kg on the horizontal axis and then trace a vertical line up until you reach the graph. Now trace a horizontal line across to the vertical axis to see the dosage required for a dog weighing 10 kg.
b 34 kg	Find 17 mg on the vertical axis and then trace a horizontal line across until you reach the graph. Now trace a vertical line down to the horizontal axis to see the weight of a dog that requires 17 mg of Valium.

Example 2 Interpret and analyse data from a graph in a practical situation

Kim, a personal trainer, has tracked the progress of a client's recent marathon training session and displays it as a distance–time graph.



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a How far had the client run after 30 minutes?
b What was the client doing between the time interval of 30 and 40 minutes?
c How long did it take the client to run 11 km?

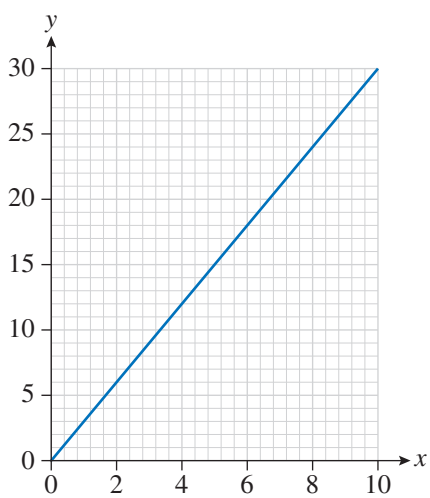
WORKING	THINKING
a 6 km	Find 30 minutes on the horizontal axis and then trace a vertical line up until you reach the graph. Now trace a horizontal line across to the vertical axis to see the distance reached after 30 minutes.
b The client was having a rest.	From the graph, it can be seen that there is a horizontal section of the graph between 30 and 40 minutes. This corresponds to no change in distance, so the client is not running anymore.
c 60 minutes	Find 11 km on the vertical axis and then trace a horizontal line across until you reach the graph. Now trace a vertical line down to the horizontal axis to see the time taken to run 11 km.

Exercise 7A

FUNDAMENTALS

1 The graph shows the relationship between x and y.

a What is the value of y when x is equal to 2?
b What is the value of y when x is equal to 7?
c What is the value of x when y is equal to 15?
d What is the value of x when y is equal to 27?



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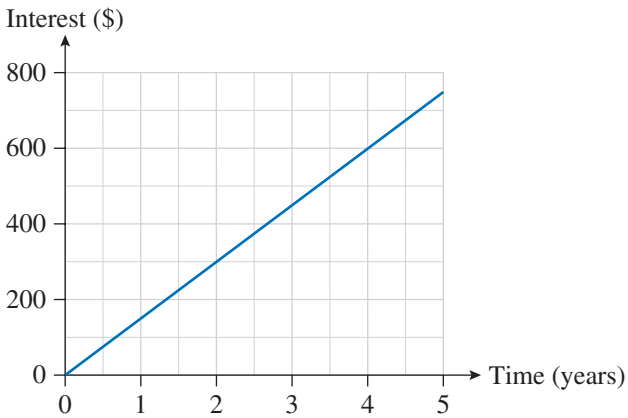
APPLICATIONS

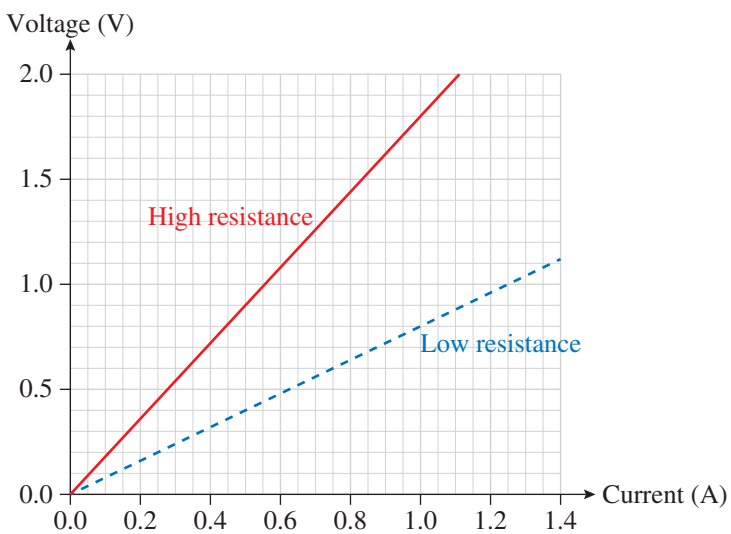
SF: 2–3 | CF: 4–6 | CU: 7–9

Example 1 ★2 The interest earnt on an amount of money is the amount of money a financial institution gives you for investing it with them.
The following graph shows the interest earned when $5000 is invested in an investment bond.



a How much interest is earned after 2 years?
b How much interest is earned after 3 years?
c How long will it take to earn $600 in interest?
d How long will it take to earn $150 in interest?

★3 An electrician uses a current–voltage graph to model the behaviour of resistors in an electrical circuit. The graph shows the relationship between current and the voltage of two resistors: one with high resistance and one with low resistance.



a Determine the voltage of the low-resistance resistor with a current of 0.5 A.
b Determine the voltage of the high-resistance resistor with a current of 0.95 A.

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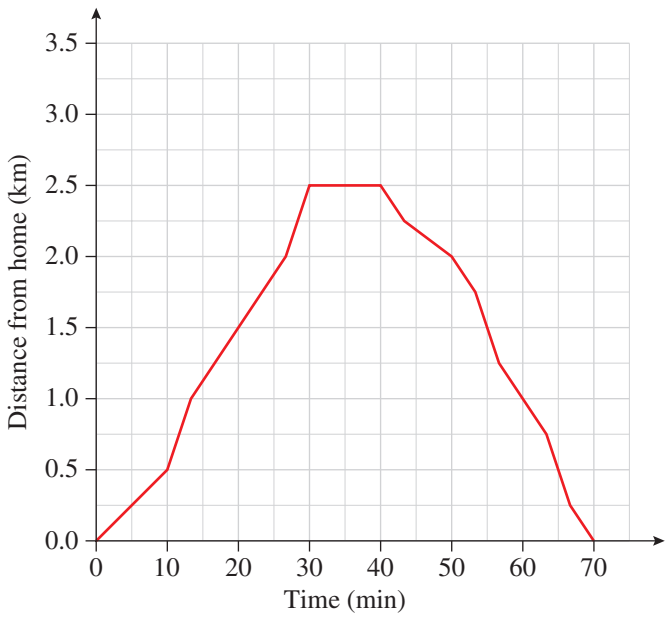
c Determine the current of the low-resistance resistor with a voltage of 0.8 V.
d Determine the current of the high-resistance resistor with a voltage of 0.9 V.

Example 2

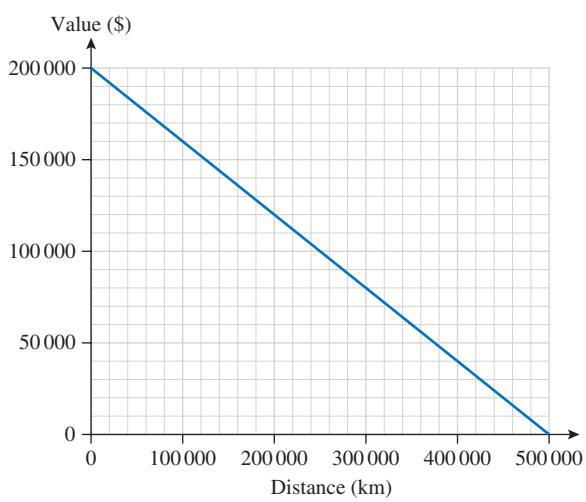
4 Below is the distance–time graph of Daniel walking to his local library and then walking back home.



a How far does Daniel walk in 10 minutes?
b How long does it take Daniel to walk 2.5 km?
c After 60 minutes, how far is Daniel from his house?

Hint 'Time' is the horizontal axis; 'Distance' is the vertical axis.

★5 The owner of a fleet of school buses wishes to be able to predict the value of his vehicles according to how many kilometres it has travelled. A graph showing how the value of a school bus depreciates over its lifetime is given.



a Estimate the value of a school bus after it has travelled 100 000 km.
b Estimate the value of a school bus after it has travelled 320 000 km.
c After how many kilometres is a school bus worth $150 000?
d After how many kilometres is a school bus effectively worth nothing?
e Give a reason why the answer to part **d** may not be realistic.

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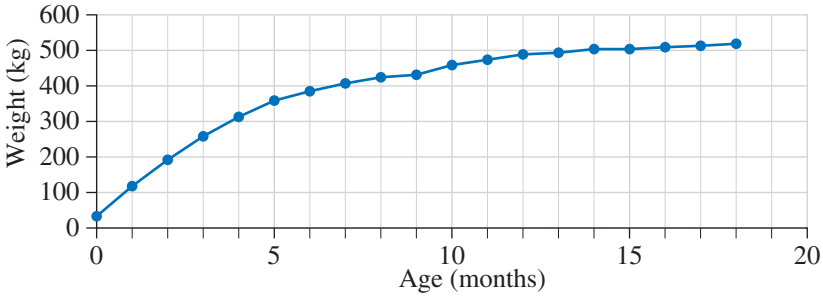
★6 A farmer measures the weight of one of his cows every month to determine when it is ready to sell at market. A graph of the cow's weight is given.



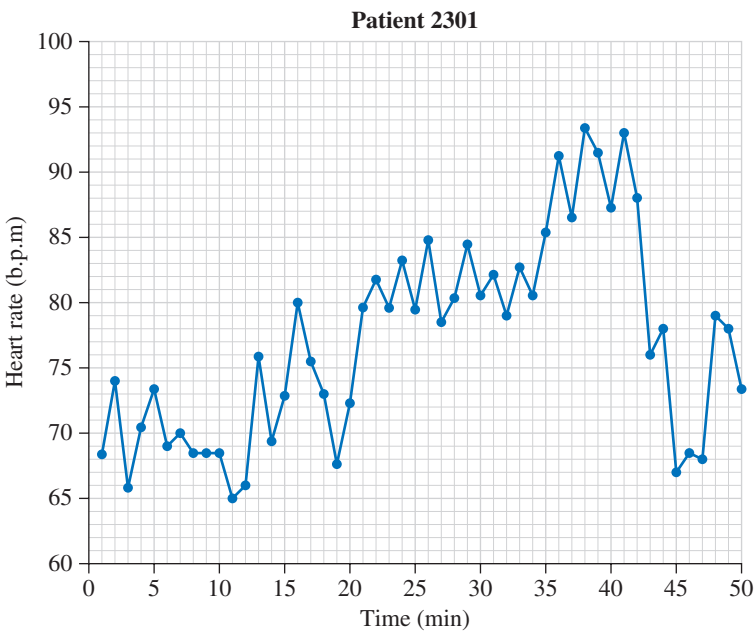
a Approximately, what is the cow's weight after 2 months?

b Approximately, what is the cow's weight after 8 months?

c Approximately, when does the cow weigh 400 kg?

d In order to sell the cow for a respectful profit, the farmer prefers the cow to weigh at least 500 kg. After how many months should the farmer sell the cow at market?

★7 James, a nurse, is assisting in a medical procedure during which he must monitor the patient's heart rate. The graph shows the patient's heart rate during the procedure.



a Estimate the patient's heart rate after 16 minutes.

b When does the patient's heart rate first get above 75 b.p.m.?

James is told to administer some medication to the patient when their heart rate goes above 90 b.p.m., in order to reduce their heart rate.

c At what point does James administer the medication?

d Estimate how long it takes for the medication to bring the patient's heart rate down to a stable level.

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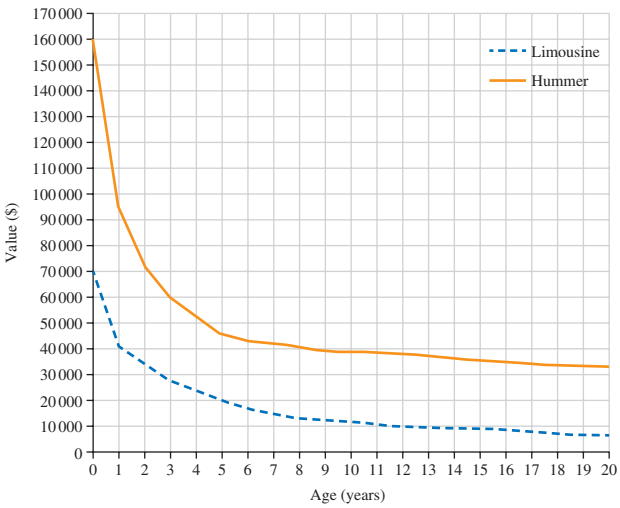
★8 Janette owns a limousine and stretch Hummer business. The line graph below shows the depreciation of both types of vehicles for the first 20 years of their lifetime.



a What is the initial cost of each vehicle type?

b Approximately, what is the value of a limousine after 3 years?

c Approximately, what is the value of a Hummer after 4 years?

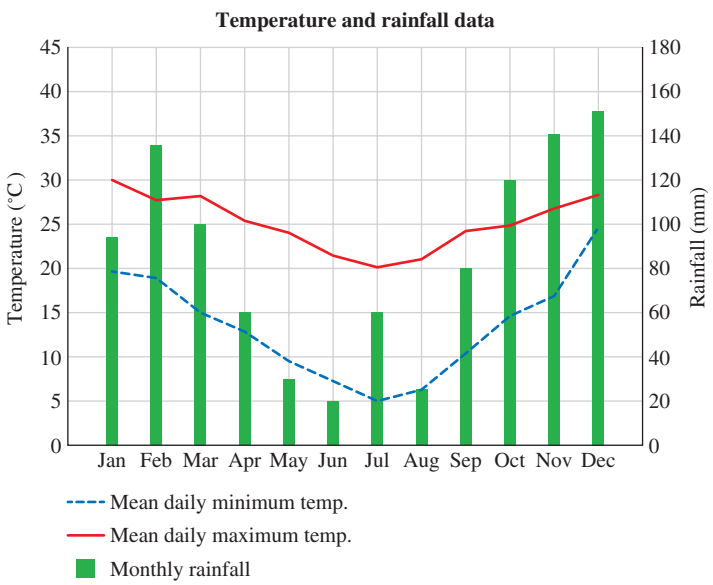
d Approximately, when is the limousine worth $20 000?

e Approximately, when is the Hummer worth $70 000?

f Using the graph, what would you estimate the value of each vehicle type to be after 25 years? Justify your response.

Hint Assume that the curves will continue their current trends. Where will they be at 25 years?

★9 The graph below, which combines a line graph and a column graph on the same set of axes, shows the weather recorded at a resort island over a period of 1 year.



a Which months had the highest/lowest rainfall?

b Which months had the highest/lowest temperatures?

c If you were to travel to this resort island for a holiday by the pool, when would be the best month? Justify your answer.

Hint What weather conditions are best suited to being by a pool?

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7B Drawing graphs from data by hand and using technology COMPLEX

LEARNING GOALS

- Hand draw graphs from data representing practical situations
- Graph data from practical situations, using a spreadsheet

How is drawing graphs for practical situations essential?

There are many situations in jobs where it is useful to draw a graph from a set of data, for example: determining the amount of tax to be paid based on income, or working out the cost of a construction depending on the amount of timber required. As it may be quite hard to interpret the relationship from the data in its raw form, drawing a graph from the data will make it much easier for the data to be interpreted and communicated.

Drawing a graph from the data makes it much easier to use and interpret the data.

WHAT YOU NEED TO KNOW

- How to draw column graphs from Exercise 5A.
- How to draw line graphs from Exercise 5C.

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Example 3 Hand draw a graph from data representing a practical situation

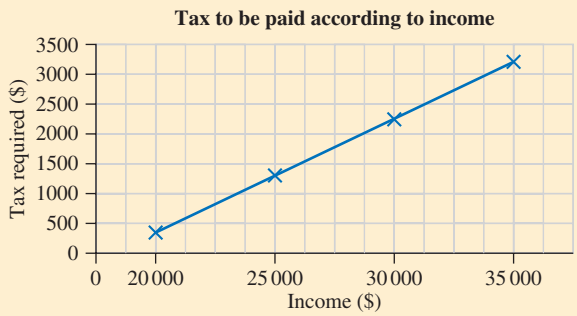
A small business owner is trying to determine how much income tax she must withhold from an employee's pay and pay to the Australian Taxation Office (ATO), depending on the income of employee. The table of values shows the amount of tax to be paid based on incomes between $18 201 and $37 000.
Note: this graph can only be used to calculate income between the amounts stated.

Income ($)	20 000	25 000	30 000	35 000
Tax amount ($)	342	1292	2242	3192

a Construct a line graph of the data given in the table by hand.
b Use the graph to estimate the amount of tax to be paid by someone who earns an income of $29 000.

WORKING

a



b Approximately $2000.

THINKING

Label the 'Income' on the horizontal axis and label the 'Tax required' on the vertical axis.

Start the horizontal axis at 20 000 and go up in increments of 5000 to 35 000.

Start the vertical axis at zero and go up in 500s to 3500.

Mark a small cross at each data point.

Join up the data points with straight lines. Be sure to use a ruler when drawing straight lines.

Use your horizontal scale to find $29 000. Trace a vertical line up to the graph line and then trace a horizontal line across to the vertical axis. Use this to estimate how much tax is required.

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Example 4 Graph data from a practical situation, using a spreadsheet

Jordan works at a timber yard and has been asked to create a graph for customers to use so they can determine how much their order will cost, depending on how many metres of 70 × 35 mm treated structural timber they require. Jordan is given the following data.

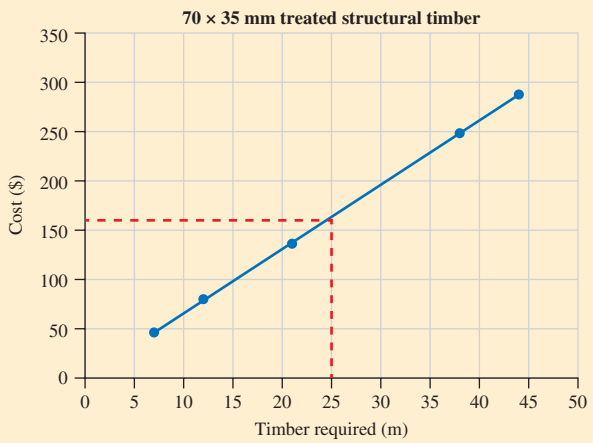
Timber required (m)	7	12	21	38	44
Cost ($)	45.50	78.00	136.50	247.00	286.00

a Using technology of your choice, create a line graph of the data.

b Using the line graph, estimate how much it will cost for an order of 25 m of 70 × 35 mm treated structural timber.

WORKING

a



b Approximately $160.

THINKING

Input the data into a graphing application such as a spreadsheet.

Select the data and choose to insert a chart.

Choose an appropriate chart from the given options.

Add elements to the chart, such as a chart title and axes titles.

Use your horizontal scale to find 25. Trace a vertical line up to the graph and then trace a horizontal line across to the vertical axis. Use this to estimate the cost of the order.

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Exercise 7B

FUNDAMENTALS

1 The table shows the data between two variables, x and y.

x	2	4	6	8	10
y	4	8	12	16	20

a Hand draw a line graph of the data presented, with x on the horizontal axis and y on the vertical axis.
b Use the line graph to find the value of y when x is 7.
c Use the line graph to find the value of x when y is 10.

Hint Remember to mark each data point as you are going along.

XLS

2 For each of the following, using technology of your choice, create a line graph of the data.

a

x	5	11	25	31
y	4	8.8	20	24.8

b

x	3	14	29	48
y	76.5	357	739.5	1224

APPLICATIONS

SF: – CF: 3–5 CU: 6–8

Example 3 ★**3** To assist with the financial records, a shop owner wishes to create a graph of how much tax he must pay the ATO, depending on how much he pays himself for the year. The table shows the amount of tax to be paid based on incomes between $37 001 and $87 000.

Income ($)	40 000	50 000	60 000	70 000
Tax amount ($)	4547	7797	11 047	14 297

a Hand draw a line graph of the data collected.
b Use the graph to estimate the amount of tax to be paid if the shop owner pays himself $55 000 for the year.

Hint Remember to use a ruler, as your graph will be more accurate.

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Example 4 ★4 A plumber has a pricing structure where there is an initial call-out fee and then an hourly rate. The table shows the cost of hiring the plumber, depending on the number of hours spent working.

XLS

Hours	0	2	4	6	8
Cost ($)	70	150	230	310	390

a Using technology of your choice, use a spreadsheet to create a line graph of this data.

b Using the line graph, estimate how much it will cost for a job that lasts 5 hours.

XLS

★5 Studies have shown that people are better able to understand instructions for administering medicine when it includes a visual aid, such as a graph. A paediatric nurse would like to create a graph that shows what dosage of a particular medicine is required for babies, depending on their weight, to the nearest kilogram. The nurse gathers the data presented in the table.

Baby's weight (to the nearest kg)	Dosage of medicine (mL)
3	0.75
4	1.00
5	1.25
6	1.50
7	1.75
8	2.00
9	2.25

Using technology of your choice, create a column graph of this data.

★6 A farmer notices that the yield of her cereal crop is dependent on how much fertiliser she uses. Over the course of four harvest seasons, the farmer collects data on crop yield (in kilograms per hectare) and amount of fertiliser used (in kilograms per hectare). The results are shown in the table.

Fertiliser used (kg/ha)	182	196	221	232
Crop yield (kg/ha)	2700	2840	3090	3200

a Hand draw a line graph of the data collected.

b Use the graph to estimate the crop yield if 200 kg/ha of fertiliser is used.

c Use the graph to estimate the amount of fertiliser required to get a crop yield of 2750 kg/ha.

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XLS

★7 An electrical engineer on a cruise ship is monitoring the temperature of a particular component according to the current running through it. The results of five measurements are given in the table.

Current (A)	1.0	1.5	2.0	2.5	3.0
Temperature (°C)	20	36	52	68	84

a Using technology of your choice, use a spreadsheet to create a line graph of this data.

b Using the line graph, estimate the temperature of the component when there is a current of 1.8 A running through it.

c The electrical engineer knows that the component will fail when it reaches a temperature above 90°C. Use your graph to estimate the current that will cause this.

★8 Francis works at a call centre that offers people the chance to sign up to a new mobile phone provider. To encourage workers to get as many people signed up as possible, the company offers cash bonuses to their employees. If a worker gets a certain number of people to sign up to the new mobile phone service in a 4-hour shift, they receive a cash bonus. A summary of the cash bonuses offered, depending on how many customers are signed up, is displayed in the table below.

Number of new customers	5	6	7	8	9	10	11	12
Cash bonus ($)	20	25	30	36	42	50	57	65

a Hand draw a column graph of the data collected.

b Using your column graph from part **a**, create a poster designed to motivate employees to sign up as many new customers as possible in each 4-hour shift.

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7C Interpreting linear graphs COMPLEX

LEARNING GOALS

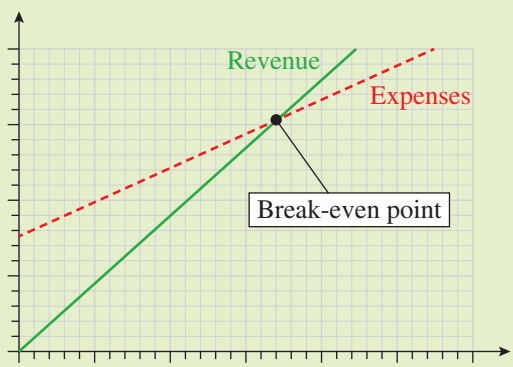
- Identify and interpret the axes intercepts of linear graphs in practical contexts
- Identify and interpret the point of intersection of linear graphs in practical contexts

Why is it essential to be able to interpret linear graphs?

When interpreting linear functions, two key features are the axes intercepts and the point of intersection. The axes intercepts give us information about what the initial conditions are or how long it will take for something to occur. For example, the point of intersection could represent the point when a company will stop making a loss and start making a profit on the production of their product. Understanding these features is essential when trying to interpret the entire graph.

WHAT YOU NEED TO KNOW

- A **linear graph** is the graph of a linear function (these are covered in more detail in Units 3 and 4). A linear graph always takes the form of a straight line on a set of axes.
- The value where a linear graph crosses the vertical axis is called the **vertical axis intercept** (sometimes known as the y-intercept).
- The value where a linear graph crosses the horizontal axis is called the **horizontal axis intercept** (sometimes known as the x-intercept).
- The point where two linear graphs intersect is called the **point of intersection**.



In a business context:

- Profit/Loss = revenue − expenses
  - If the result is positive, then this is a **profit**.
  - If the result is negative, then this is a **loss**.
- The point on a graph showing revenue and expenses where the revenue changes from being below the expenses to above the expenses is known as the **break-even point**, as shown here.

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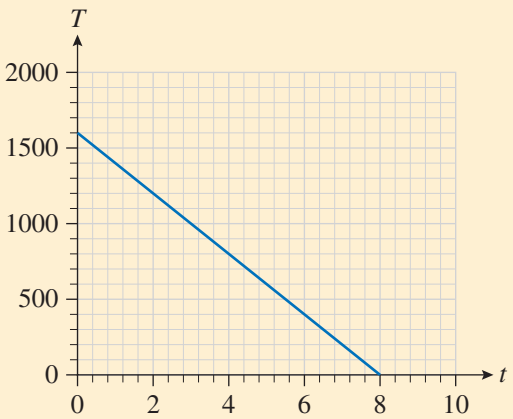
Example 5 Identify and interpret the axes intercepts of a linear graph in a practical context

A small business selling a trending toy has set up a stall at a toy market. The business owners are worried about stock levels throughout the day and so they have set up their computer to record how many toys they have left to sell. A graph of the number of toys remaining (T) against time (t), in hours, is presented.



a What is the number of toys remaining after 2 hours?

b How long does it take for the number of toys remaining to drop to 600?

c Identify and interpret the vertical axis intercept.

d Identify and interpret the horizontal axis intercept.

WORKING	THINKING
a 1200	Using your finger to trace the vertical line at 2 hours up to the graph, it can be seen that the number of toys remaining at this time is 1200.
b 5 hours	Using your finger to trace the horizontal line at 600 toys across to the graph, it can be seen that the time at this point is 5 hours.
c The initial number of toys available to sell is 1600.	The vertical axis intercept occurs when the graph crosses the vertical axis. This is when the time is 0 hours and the number of toys is 1600. This corresponds to the initial number of toys in stock.
d The business will run out of toys to sell after 8 hours.	The horizontal axis intercept occurs when the graph crosses the horizontal axis. This is when the time is 8 hours and the number of toys is zero. This corresponds to the amount of time taken for the business to run out of toys.

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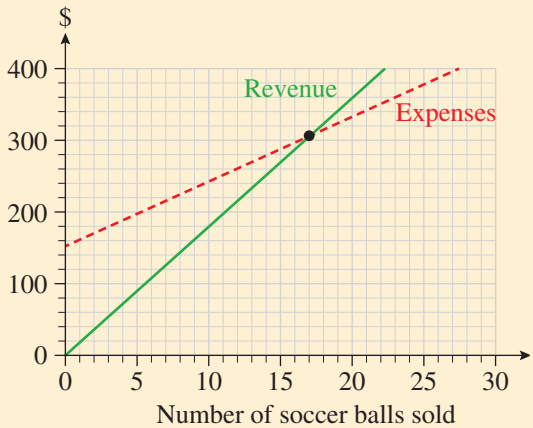
Example 6 Identify and interpret the point of intersection of a real-life linear graph

A vendor who sells soccer balls at sporting venues will have a varying amount of profit, depending on how many soccer balls she sells. The graph shows the revenue made (i.e. money made from selling the soccer balls) in green and the expenses (i.e. how much it costs to make the soccer balls) in red, against the number of soccer balls sold.



a If the vendor sells no soccer balls, will the vendor make a profit or a loss?

b Using the formula profit/loss = revenue – expenses, approximate the profit/loss when the vendor sells 10 soccer balls.

c Identify and interpret the point of intersection.

WORKING	THINKING
a Loss	If the vendor sells no soccer balls, then the revenue is \$0 and the expenses are \$150. This is a loss of \$150.
b Profit/Loss = 180 − 240 = –60 Loss of approximately \$60.	By reading the graph when 10 balls are sold, the revenue is approximately \$180 and the expenses are approximately \$240. Using the profit/loss formula gives –60. This corresponds to a loss of approximately \$60.
c The point of intersection occurs at 17 soccer balls and approximately \$310. This means that when the vendor sells fewer than 17 soccer balls, she will make a loss. If the vendor sells more than 17 soccer balls, she will make a profit. This is the break-even point.	By looking at where the two linear graphs intersect, it can be seen how many soccer balls the vendor needs to sell for her to make a profit.

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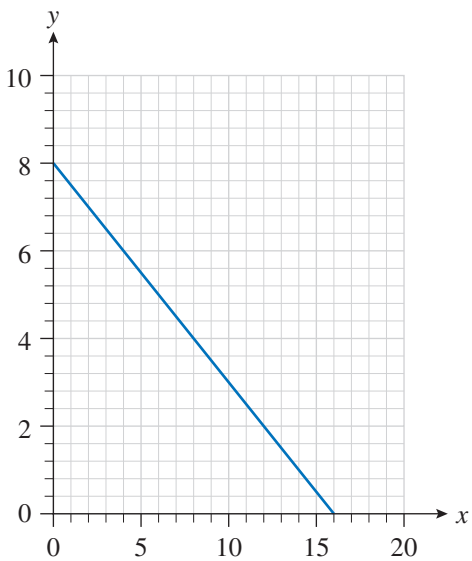
Exercise 7C

FUNDAMENTALS

1 The graph shows the relationship between the variables x and y.



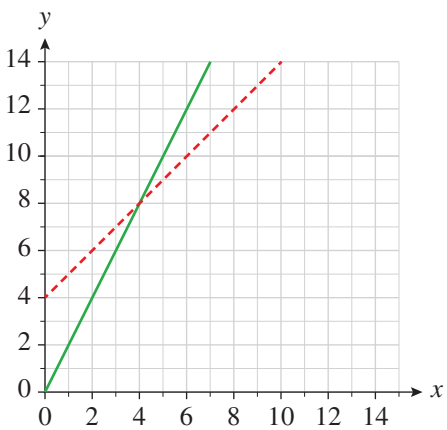
- **a** What is the value of y when x is equal to 10?
- **b** What is the value of y when x is equal to 3?
- **c** What is the value of x when y is equal to 5?
- **d** What is the value of x when y is equal to 3.5?
- **e** Identify the vertical axis intercept.

> **Hint** At which value does the line intercept the axis?

- **f** Identify the horizontal axis intercept.

2 For each of the following graphs, state the x and the y value for the point of intersection.

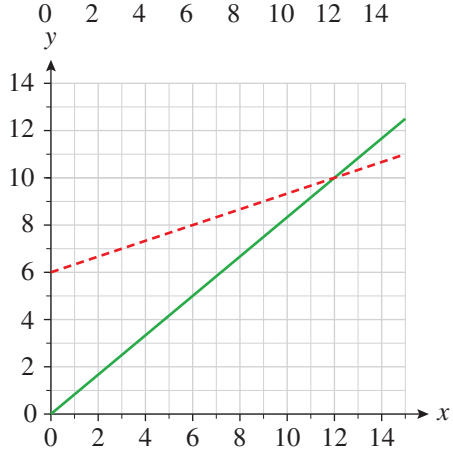
a



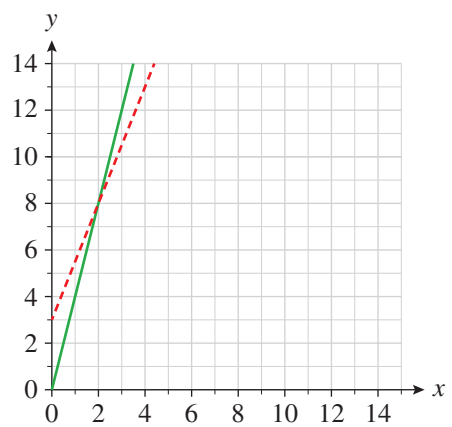
> **Hint** At which point do the two lines intercept?

> **Hint** When writing the values, give the x value then the y value.

b



c



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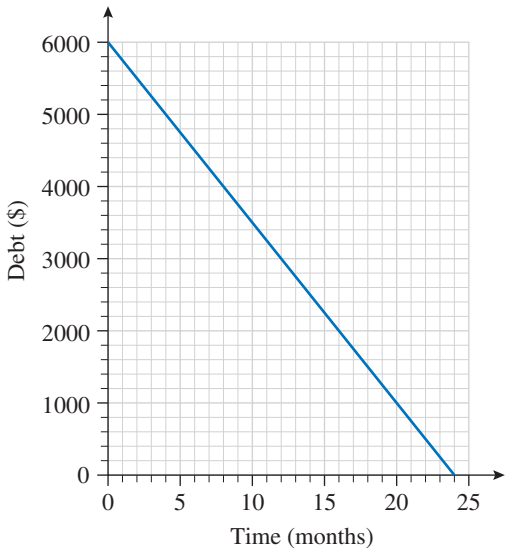
APPLICATIONS

SF: – | CF: 3–5 | CU: 6–7

Example 5 ★3 A small business has accumulated some debts. The owners of the business have made a graph to work out how long it will take them to be debt free.



a How much money will be owed after 4 months?

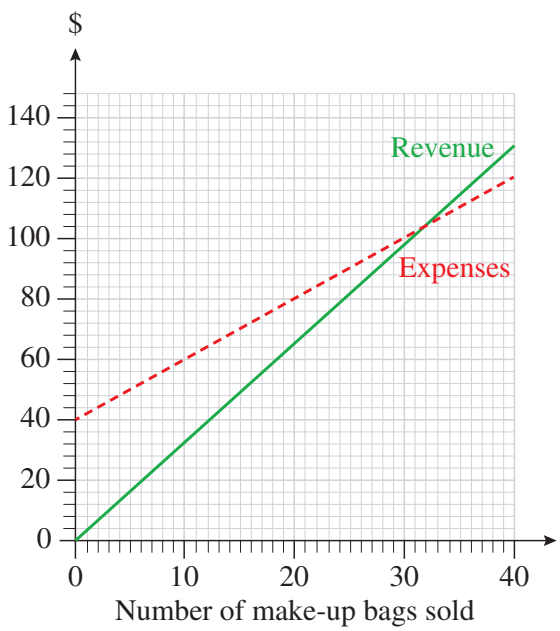
b After how many months will $2000 still be owed?

c Identify and interpret the vertical axis intercept.

Hint Where will the line intercept the axis?

d Identify and interpret the horizontal axis intercept.

Example 6 ★4 Kacey owns a small business selling make-up bags. The amount of money that Kacey makes from selling the make-up bags at a market depends on how many she sells each month. The graph shows the revenue made (i.e. money made from selling the make-up bags) in green and the expenses (i.e. how much it costs to sell the make-up bags) in red, against the number of make-up bags sold in a month.



a If Kacey sells 10 make-up bags:

i approximately, what will be her revenue?

ii approximately, what will be her expenses?

iii approximately, how much money will Kacey lose from selling only 10 make-up bags?

Hint Profit/Loss = revenue – expenses

b Approximately, find how much profit Kacey will make from selling 40 make-up bags.

c Identify and interpret the point of intersection.

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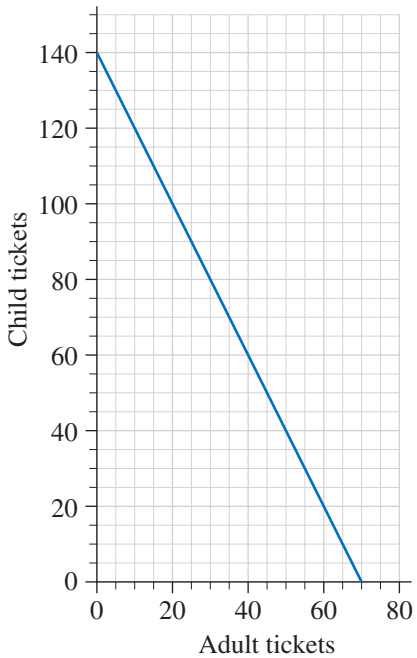
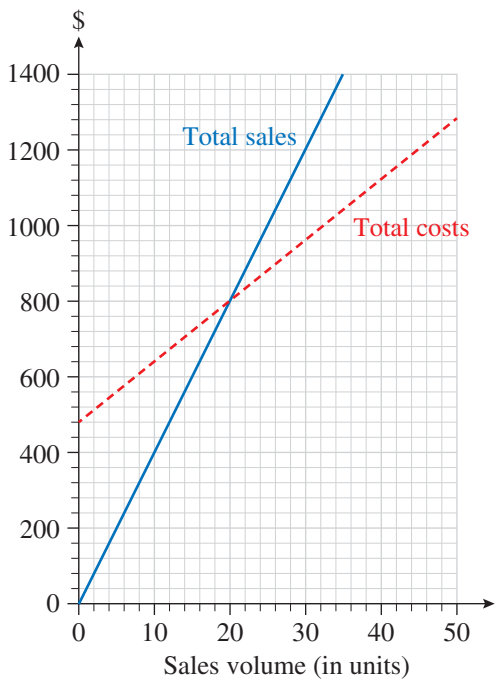
★5 A small theatre company is putting on a production. It knows that it must sell at least $350 worth of tickets to start making a profit. The graph shows the number of adult and child tickets that must be sold to make $350.



- **a** How many child tickets are required to be sold if 40 adult tickets are sold?
- **b** How many adult tickets are required to be sold if 110 child tickets are sold?
- **c** Identify and interpret the vertical axis intercept.
- **d** Identify and interpret the horizontal axis intercept.

★6 A small business sells rugby league training equipment sets for $40 each, with variable costs of $15 per unit and a total fixed cost. This information is shown in the graph.



- **a** Identify and interpret the vertical axis intercept of the graph of total costs.
- **b** Determine the profit/loss from selling 10 units.
- **c** Determine the profit/loss from selling 26 units.
- **d** Determine the company's break-even point, in units.
- **e** Determine the company's break-even point, in dollars.

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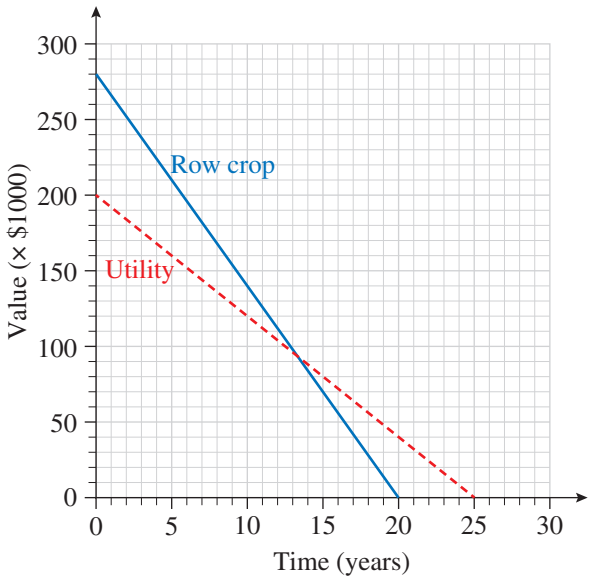
★7 A farmer buys two new tractors for his farm: one utility tractor and one row crop tractor. He knows that each tractor's value will depreciate with each year that he owns them. To avoid selling them past a certain value, the farmer draws a graph of their value against time, as shown.



a Determine the value of the utility tractor after 10 years.
b Determine the value of the row crop tractor after 17 years.
c Identify and interpret the vertical axis intercept of the utility tractor.
d Identify and interpret the horizontal axis intercept of the utility tractor.
e Identify and interpret the vertical axis intercept of the row crop tractor.
f Identify and interpret the horizontal axis intercept of the row crop tractor.
g Identify and interpret the point of intersection.
h The farmer wishes to keep the tractors until they reach a value of $50 000. How long does the farmer estimate to keep each tractor?

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Problem-solving and modelling task

USING GRAPHS TO CHOOSE A HOLIDAY DESTINATION

Background: Graphs are often the best tool for communicating complex information that aims to present comparisons for a decision or choice.
You have been asked by your club to gather and present information to help the members decide which destination to choose for a special celebration of the club's founding.
Your task is to select five possible destinations and to draw five rainfall and temperature graphs to help choose the climate that suits the club's outdoor activities best. You must compare and contrast rainfall and temperature for each destination and recommend which place is the most suitable for the club, and what time of year to go.

To complete this task, follow the problem-solving workflow diagram below and use the steps listed as a guide.

Stage 1: Formulate

1 Decide on five destinations.
2 Describe what kind of climate would suit the club best.

Stage 2: Solve

3 For each destination, research the monthly average rainfall and temperature for the past year and gather data to create the graphs.
4 For each destination, research the monthly average temperature for the past year.
5 Decide what type of graph to produce and create them using technology of your choice.
6 Describe how well each destination matches the required climate and decide which destination to recommend and when to go.

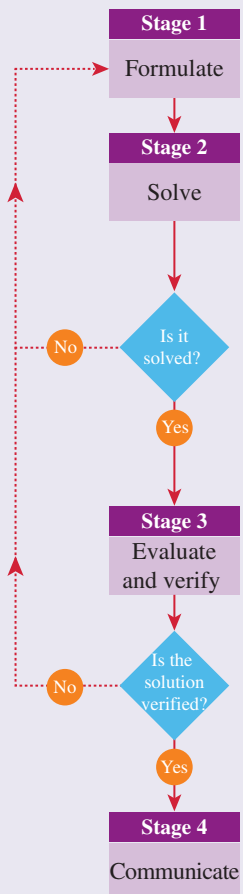
Stage 3: Evaluate and verify

Once you have developed your graphs, consider:

7 Have you presented them in the most suitable way?
8 Have you decided on your recommendations and can you justify them?

Stage 4: Communicate

9 Communicate your findings in a short report to the club that justifies your recommendations.
10 Include an Introduction (the kind of climate that will suit the club's activities), Body (presenting the destinations and graphs) and Conclusion (recommendations of destination and time of year).



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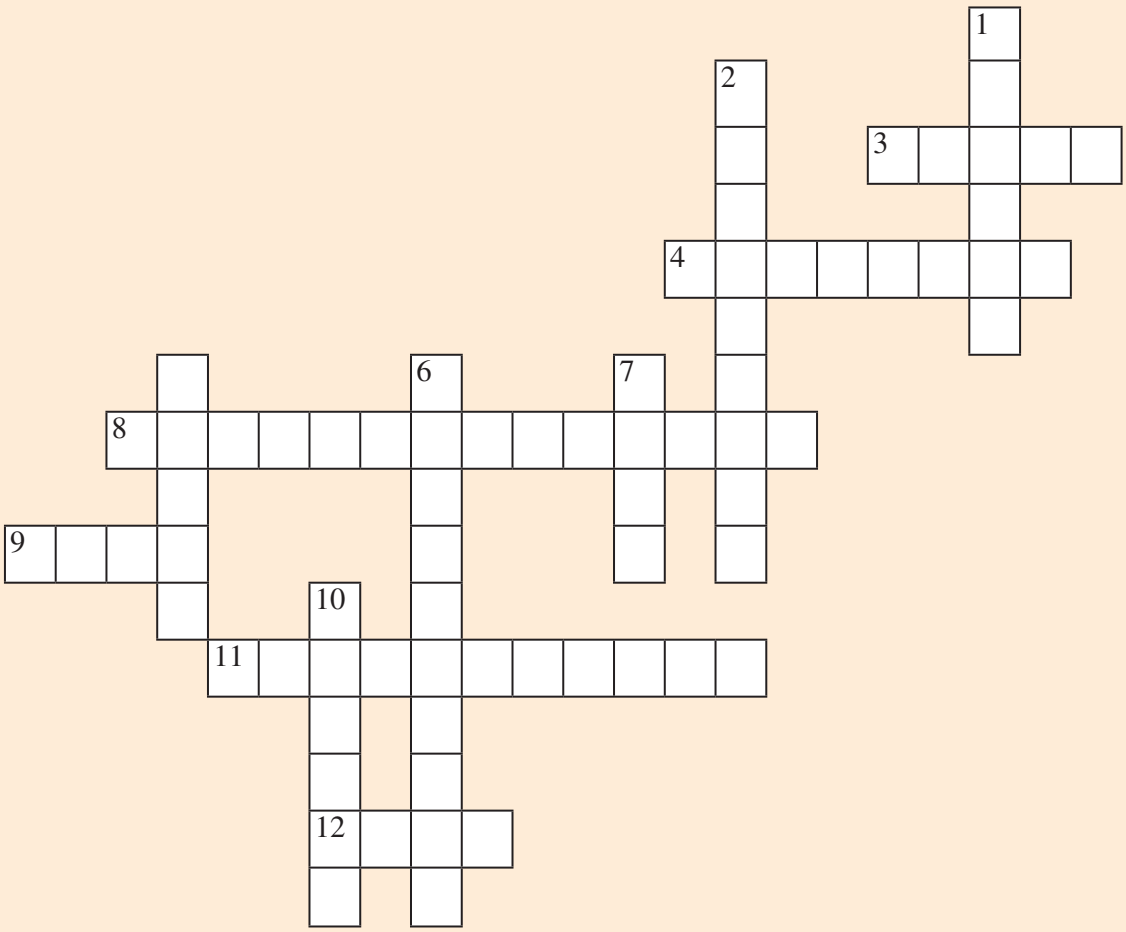
Puzzle



Across

3 A visual representation of information
4 The *y*-axis is usually the _____ axis.
8 A collection of questions given to someone to gather information
9 A graph that shows information that is connected in some way as time changes is a _____ graph.
11 When reading percentages off a graph, we are reading the _____.
12 Another word for the average value

Down

1 To graph using technology, the data must be put into a _____sheet.
2 Drawing a graph will help you to _____ the results.
5 When joining lines by hand, always use a _____.
6 The *x*-axis is usually the _____ axis.
7 Facts and statistics collected together for reference or analysis
10 Another name for a bar chart is a _____ graph.

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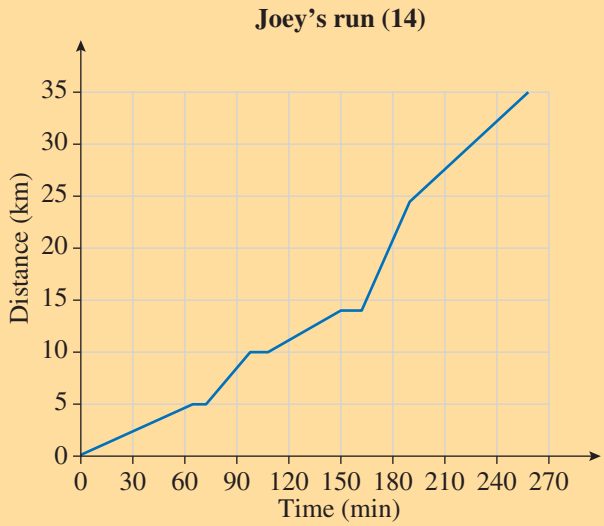
Chapter checklist

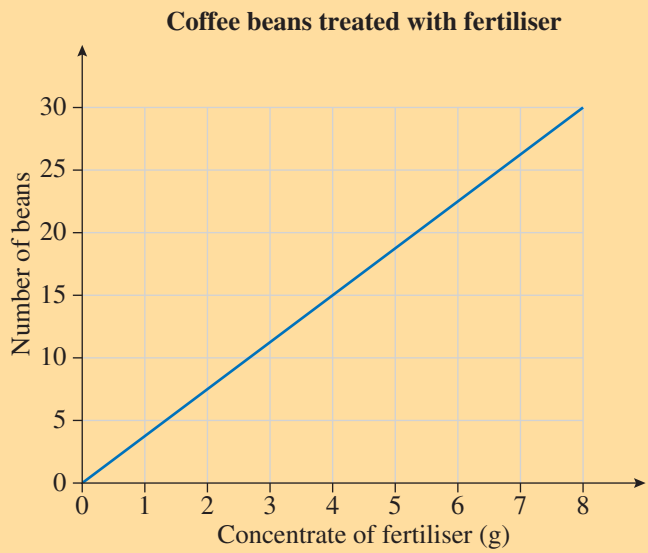
☐ I can interpret data from graphs of practical situations [Complex].

1 Given the distance–time graph shown, what distance and time did Joey achieve on her 14th run?



☐ I can analyse data from graphs of practical situations [Complex].

2 Referring to the line graph shown, how much fertiliser is required for a minimum of 15 beans to grow?



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☐ I can hand draw graphs from given data to represent practical situations [Complex].

3 Hand draw a line graph of the data below.

Current tax allocations				
Income ($)	40000	50000	60000	70000
Tax amount ($)	3798	6532	10675	13542

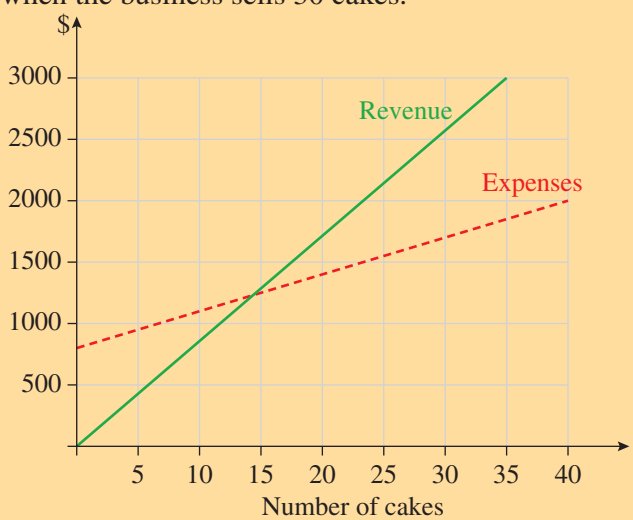
☐ I can draw graphs from given data to represent practical situations [Complex].

4 Using technology of your choice, create a line graph of the data below, using a spreadsheet.

Cost of hiring a gardener					
No. of hours	0	2	4	6	8
Cost ($)	50	150	250	350	450

☐ I can interpret the point of intersection on a linear graph.

5 Using the formula profit/loss = revenue – expenses, approximate the profit/loss when the business sells 30 cakes.



☐ I understand the terms vertical axis intercept (y-intercept) and horizontal axis intercept (x-intercept) [Complex].

6 Identify and interpret the point of intersection from the previous graph.

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Chapter review

All questions in the Chapter Review are assessment-style.

Simple Familiar

1 Emma, who works at a café, gets paid according to how many hours she works in a week. The table shows how much Emma is paid for a certain number of hours worked for that week.

Hours	19	23	27	35
Pay ($)	342	414	486	630

a Hand draw a line graph of this data, joining all points with a straight line.

b Using the line graph, estimate how much Emma would get paid for working 30 hours in a week.

c Using the line graph, estimate how many hours Emma must work in order to earn $300 in a week.

2 A veterinarian is putting together an informative chart for the dosage of medication required for cats, depending on their weight, when rounded to the nearest kilogram. The data that needs to be graphed is given below.

Cat's weight (to the nearest kg)	**Dosage of medicine (mL)**
1	1.2
2	1.4
3	1.7
4	2.0
5	2.4
6	3.0

Using technology of your choice, use a spreadsheet to create a column graph of the data.

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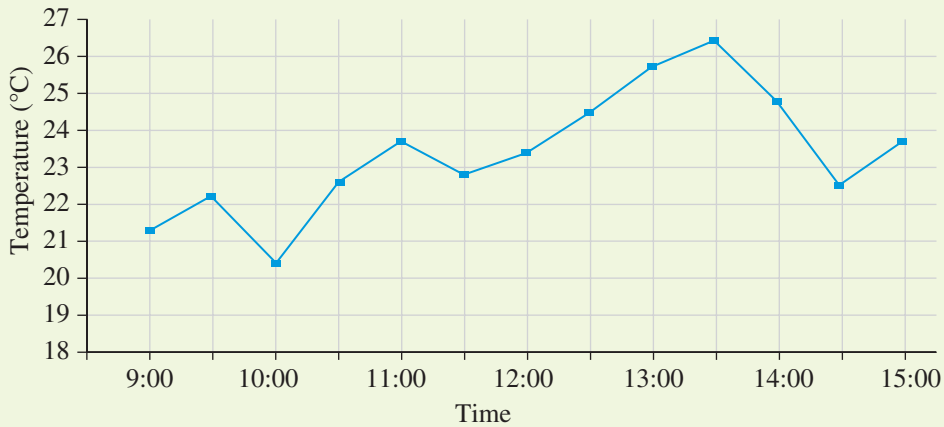
Complex Familiar

3 One of the responsibilities of Will, an aquaculture worker, is to monitor the condition of the fish in a particular tank. Will has been instructed to turn off a water heater when the water temperature rises above 25°C. To monitor the temperature, there is a graphical display showing the current temperature and a graph of how the temperature has varied over the past 6 hours, as shown below.



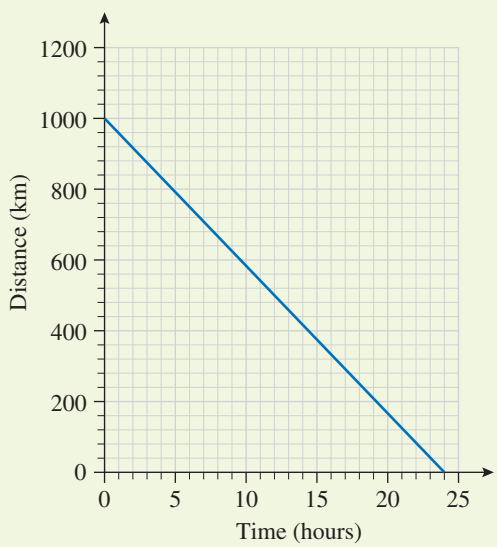
a Estimate the temperature of the water in the tank at 10 a.m.

b Estimate the temperature of the water in the tank at 11:30 a.m.

c At what time does the temperature of the water first rise above 25°C?

d When does the graph suggest that Will has turned off the water heater? Justify your response.

4 Frankie is on a direct train from Katherine to Alice Springs and is travelling at a constant speed. The distance from Alice Springs, in kilometres, against time, in hours, is shown in the graph.



a Approximately, how far from Alice Springs is Frankie after 6 hours?

b Approximately, how long does it take for Frankie to be 400 km from Alice Springs?

c Identify and interpret the vertical axis intercept.

d Identify and interpret the horizontal axis intercept.

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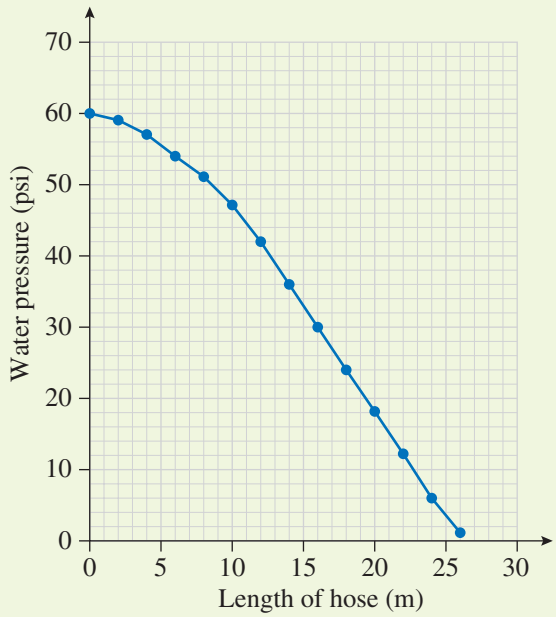
5 A landscaper is installing an automated water system for a client. As the length of hose increases, the water pressure at each sprinkler decreases. The landscaper graphs this relationship, as shown right, in order to discuss it with the client.



- **a** What is the water pressure when 12 m of hose is used?
- **b** What is the water pressure when 8 m of hose is used?
- **c** The client does not wish the water pressure to drop below 30 psi. Up to what length of hose does this allow the landscaper to install?

6 An accountant for a gym has been given the task of estimating the value of its range of motion machine, depending on its age. The accountant gathers data on how the value of the range of motion machine varies with age. The results are given in the table.

Age (years)	3	5	9	11
Value ($)	12750	11250	8250	6750

- **a** Using technology of your choice, use a spreadsheet to create a line graph of the data. Display age on the horizontal axis, going from 0 to 25 years, and value on the vertical axis, going from $0 to $20000.
- **b** Using the line graph, estimate how much the range of motion machine is worth after 7 years.
- **c** Using the line graph, estimate after how many years the range of motion machine will be worth $10000.
- **d** State the value of the vertical axis intercept and interpret this value.
- **e** State the value of the horizontal axis intercept and interpret this value.

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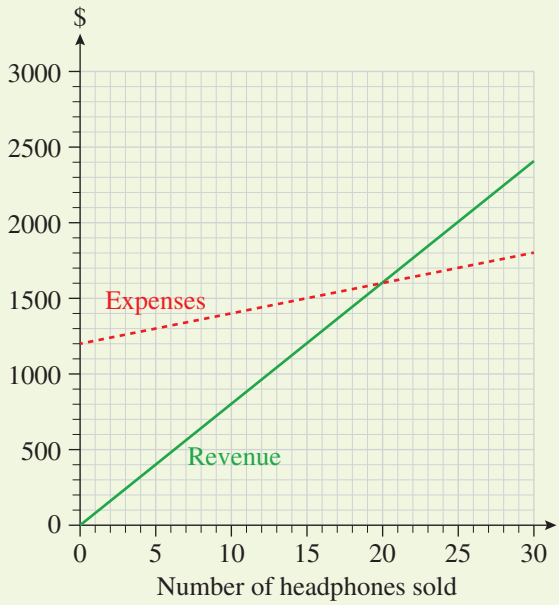
7 A company that sells headphones will have a varying amount of profit, depending on how many headphones it sells. The graph shows the revenue made (i.e. money made from selling the headphones) in green and the expenses (i.e. how much it costs to make the headphones) in red, against the number of headphones sold.



a Approximate the profit/loss when the company sells five headphones.
b Approximate the profit/loss when the company sells 25 headphones.
c Identify and interpret the vertical axis intercept of the graph of expenses.
d Identify and interpret the point of intersection.

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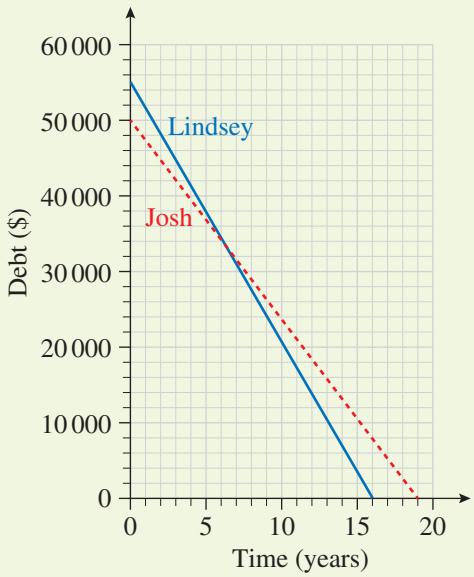
Complex Unfamiliar

8 Both Lindsey and Josh have entered the workforce with a sizeable debt from paying for their education. They both pay off their debt in regular payments until it is paid off. In order to forecast how much they each have left to pay, Josh creates the graph shown of how much they each owe.



a Approximately, how much does Josh have left to pay after 10 years?

b Approximately, how much does Lindsey owe after 2 years?

c Approximately, after how many years will Josh have just $10 000 owing?

d Approximately, after how many years will Lindsey have just $16 000 left to pay?

e Identify and interpret the vertical axis intercept for the graph of Josh's debt.

f Identify and interpret the vertical axis intercept for the graph of Lindsey's debt.

g Identify and interpret the horizontal axis intercept for the graph of Josh's debt.

h Identify and interpret the horizontal axis intercept for the graph of Lindsey's debt.

i Identify and interpret the point of intersection.

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8 Earning Money

Maths for a hospitality business owner: Andrew Foster

Andrew Foster started by purchasing a fast-food franchise and built up the business to seven stores. After selling out of SUBWAY® he then started his own brands.

Tell us a bit about your job. What does a typical day look like?

As a business owner of multiple hospitality businesses my days are pretty busy! They include everything and anything that needs doing. I generally dedicate certain parts of the day for different tasks so I can ensure that things run smoothly. I like to stay in touch with operations and customer service so that I don't lose my skills. In business, there are so many tasks that need doing that juggling and prioritising jobs is a must.

What maths did you study at school?

I did Maths B, Maths C and Physics. I enjoyed understanding the complexity of maths and just how useful it can be in everyday life. I like that there is a structure and a system to maths.

How do you use maths in your job? Could you give some examples?

I use maths every day in my business. From simple cash calculations on the Point of Sale to complex spreadsheets, it is essential to the function of business. A simple profit and loss gives a great overview of a business' profitability and it is crucial to understand the numbers well for the success of the business. I tend to use percentages when assessing the spreadsheet and have targets that I and my team aim for. For example, we aim for a food cost of 31% of sales. We monitor this by entering the numbers into a spreadsheet monthly and then applying the percentage to each number so we can see the proportion of money we are spending on purchases each month. This also applies to other numbers such as total profit/loss, labour cost, electricity, etc.

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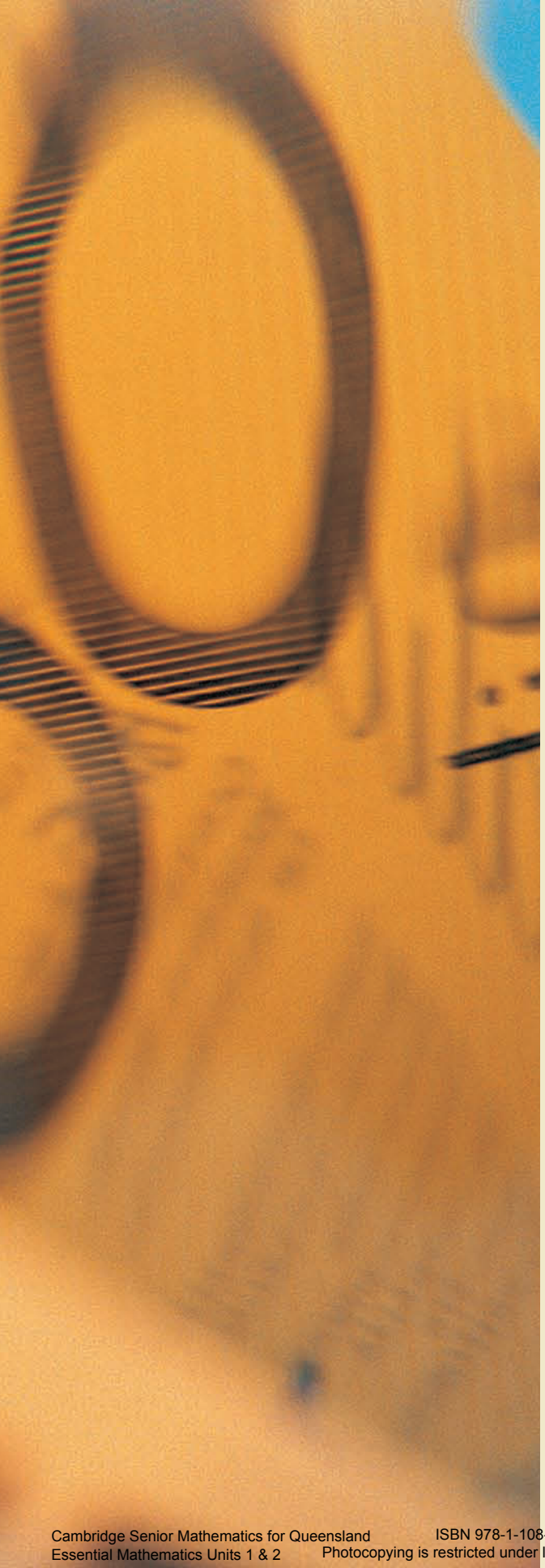

In this chapter

8A Earning a salary compared to a wage

8B Wages and overtime

8C Income by piecework and commission

8D Converting income between various time periods **[complex]**

8E Understanding taxation and superannuation

8F Calculating PAYG tax using periodic tax tables **[complex]**

8G Applying tax deductions to find taxable income **[complex]**

8H Medicare levy **[complex]**

8I Calculating simple tax returns **[complex]**

Problem-solving and modelling task

Puzzle

Chapter Checklist

Chapter Review

Syllabus reference

Unit 2 Topic 1

In this subtopic, students will:

- find earnings, including salary, wages, overtime, piecework and commission
- convert between annual, monthly, fortnightly, weekly and hourly rates of earning **[complex]**
- understand the purpose of superannuation
- interpret entries on a selection of wage or salary payslips and timesheets
- understand the purpose of taxation and the use of tax file numbers
- use tax tables to determine PAYG tax for periodic (weekly/fortnightly/monthly) earnings **[complex]**
- interpret entries on a simple PAYG summary
- apply the concepts of taxable income, gross income, allowable deductions and levies in simple contexts **[complex]**
- calculate a simple income tax return and net income, using current income tax rates **[complex]**.

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Pre-test

1 Change the following times to 24-hour time.

a 4:45 a.m. **b** 10:30 a.m. **c** 12: 25 p.m.

d 5:50 p.m. **e** 10: 33 p.m. **f** 12:40 a.m.

2 Calculate how much the following people earn in a day.

a Jeffery earns $20 per hour and works 9 hours every day.

b Federica earns $875 weekly and works 5 days a week.

c Sandeep earns $645 every 3 days.

3 At what time do the following people start work?

a Stefania must work for 7 hours. She then picks up her daughter at 3:30 p.m.

b Matilda works 8 hours a day and goes home at 5:30 p.m.

c Miles works 5 days a week and ends work at 6:45 p.m. to cook for his family. He must work at least 45 hours a week to meet his employer's requirements. He works the same amount of time every day.

4 Henry is giving a raise to all his employees. How much will they now earn annually?

a Gregor used to earn $50 000 and receives a raise of 4.5%.

b Javier used to earn $17 800 per quarter and receives a raise of 3.75%.

c Rochelle used to earn $1375 per week and receives a raise of 5.25%.

5 Calculate how many hours these people work per week.

a Fiona works 4 days a week, 8 hours a day.

b Lydia works for 138 hours a month.

c Hafu works 2990 hours a year.

A link to a HOTmaths lesson is provided in the Interactive Textbook to revise this topic.

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8A Earning a salary compared to a wage

LEARNING GOALS

- Identify the differences between:
  - a salary and a wage
  - gross pay and net pay
- Read work hours and pay information from payslips, rosters and timesheets
- Calculate wages and wage rates in real-world contexts
- Express minutes as a fraction and express the decimal value of an hour

What is the essential difference between a salary and a wage?

A salary is a fixed income per year; it is independent of the time taken to complete the work. Examples of careers paid by salary include psychologists, teachers, engineers, project managers, accountants, industrial designers, chefs and IT project managers.

Panel beaters are paid around $26 per hour. Their weekly wage is calculated from the number of hours worked.

A wage is income earned either as dollars per hour or per completed job. Examples of jobs paid by the hour include dental assistants, personal assistants, construction workers, delivery drivers and retail salespeople. Jobs that are paid per piece of work completed include fruit picking, bricklaying, seamstresses, hairdressers and carpet layers.

WHAT YOU NEED TO KNOW

- **Income** is money that a person earns when **employed** (i.e. the person has a job).
- An **employee** is the name for any employed person.
  - For example, a cashier working at IGA is an employee who is employed.
- An **employer** is the company or organisation or business owner who employs and pays the workers (i.e. the employees).
  - For example, employers include Bunnings, Flight Centre, SUBWAY®, JB Hi-Fi, IGA.

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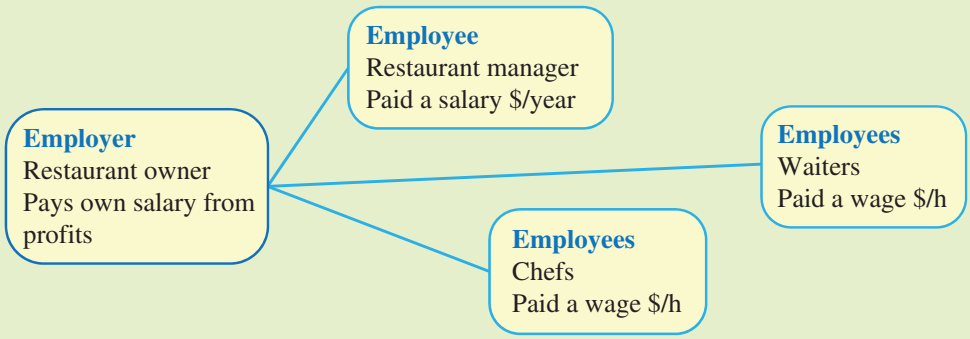

- **Per annum (p.a.)** means per year; **annually** means every year; an **annual** income is a yearly income.
- **Gross** pay is income earned before tax has been taken out to pay the Australian Taxation Office (ATO). **Net** pay is income earned after tax has been paid.
  Net pay = gross pay – tax paid
- There are two main categories of income: a salary and a wage.
- A **salary** is a fixed annual income paid for a set of responsibilities, such as a manager. The total salary is divided up into equal fortnightly (or weekly or monthly) pay amounts. The pay does not depend on the hours worked, as work hours will average out over the year.
  - For example, teachers receive a salary, a fixed pay per fortnight. No extra money is paid for attending parent–teacher interviews or school camps.
- A **wage** is often paid at a rate per hour, with the total amount earned dependent on the hours worked. A wage earner also can be paid based on the quantity of work completed.
  - For example, a mechanic is paid per hour worked, earning a wage; a seamstress is paid per 20 pieces (e.g. shirts) sewed; and a fruit picker is paid per bin of fruit picked.
- A **payslip** lists the hours worked, the gross and net income, superannuation contributions and the amount of tax withheld. Employers are legally required to provide all employees with a payslip within one working day of payday. It can be on paper or in electronic form, such as an email.
- A **timesheet** lists the number of hours worked by the wage earner, over the pay period (e.g. per fortnight).
- When converting time to a decimal number, divide the number of minutes by 60.
  - For example: 8 hours and 12 minutes $= 8 + \frac{12}{60} = 8 + 0.2 = 8.2$ hours

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Example 1 Reading pay information from a payslip

For each of the following, refer to the payslip image below.

a Decide whether you think that Lisa is paid a salary or a wage.
b Identify how many hours Lisa worked over the past two weeks.
c Identify how much Lisa earns per hour.
d Identify her total gross pay (i.e. before tax is taken out) for the two weeks.
e Identify her total net pay (i.e. the amount she receives in her bank account).

Employee Payslip – Pay Period Ending: 03/12/2018

Pay Component	Hours	Salary Code	Hourly	Rate	Amount
ORD CASUAL	62		$22.75		$1410.50

Name: Lisa McCarthy
Address: 72 Illiard Crt Buderim 4556

Gross	$1410.50	Tax	$162.00	Net	$1248.50
YTD Gross	$15 585.70	YTD Tax	$1684.25	YTD Net	$13 901.45

Accrued Annual Leave (Hours): 0

Banking details:	Amount
YouBank a/c 73214	$1248.50

Superannuation	Amount
ME Super	$134.00

WORKING

a Wage

b 62 hours

c $22.75

d $1410.50

e $1248.50

THINKING

a Lisa earns a wage because the pay component on her payslip is ORD CASUAL. Also, the fact that she has no accrued leave could indicate this.

b Look for hours or hours worked on payslip.

c Look for hourly rate on payslip.

d Look for gross or gross pay on payslip.

e Look for amount or net on payslip.

Example 2 Calculating hours worked from a roster timetable

Rebecca works as a sales assistant at Bunnings. Use the information given in Rebecca's roster timetable to answer these questions.

a Calculate how many hours and minutes Rebecca worked that week.
b Determine how many hours, in decimal form, Rebecca worked that week.

Date	Start and finish time
Monday 11/3	6 a.m. to 1 p.m.
Tuesday 12/3	–
Wednesday 13/3	6 a.m. to 1 p.m.
Thursday 14/3	1:30 p.m. to 7 p.m.
Friday 15/3	2 p.m. to 9:30 p.m.
Saturday 16/3	8 a.m. to 2:15 p.m.
Sunday 17/3	–

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WORKING **THINKING**

a

	Hours	Minutes
Monday	7	
Wednesday	7	
Thursday	5	30
Friday	7	30
Saturday	6	15
Total	33	15

Break up the time into parts for easier calculations. For example:
Mon 6 a.m. to 12 p.m. = 6 hours plus
12 p.m. to 1 p.m. = 1 hour.
Thurs 1:30 p.m. to 6:30 p.m. = 5 hours plus
6:30 p.m. to 7 p.m. = 30 minutes; total =
5 hours and 30 minutes.
Add the number of hours and minutes separately.
Total = (7 + 7 + 5 + 7 + 6) hours
+ (30 + 30 + 15) minutes
= 32 hours + 75 minutes
= 33 hours + 15 minutes

b 33 hours + $\frac{15}{60}$ hours
= 33 hours + 0.25 hours
= 33.25 hours

Refer to your answer from part **a**.
To write 15 minutes in hours, divide the number of minutes by 60 (because there are 60 minutes in 1 hour). Write the number of hours worked in decimal form.

Example 3 Reading a wage timesheet

To answer the following questions, refer to this timesheet.

TIMESHEET

Employer's name: Turkey Pies Co

Employee's name: Rachel Brown

Period (date/month/year): 3/3/2019 to 17/3/2019

Pay date (date/month/year): 20/3/2019

Type of employment: Casual

Day/Date	Start time	Finish time	Unpaid breaks	Total hours (minus unpaid breaks)
Monday 3/3/19	8:30 a.m.	1:30 p.m.	Nil	5 h
Tuesday 4/3/19	8:30 a.m.	4:30 p.m.	30 min	7 h 30 min
Thursday 6/3/19	1 p.m.	5 p.m.	Nil	4 h
Friday 7/3/19	11 p.m.	8 p.m.	30 min	8 h 30 min
Monday 10/3/19	8:30 a.m.	2:30 p.m.	15 min	5 h 45 min
Tuesday 11/3/19	8:30 a.m.	5:30 p.m.	30 min	8 h 30 min
Wednesday 12/3/19	11 p.m.	6 p.m.	30 min	6 h 30 min
Saturday 15/3/19	9 a.m.	1 p.m.	Nil	4 h
			TOTAL	

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a Calculate how many hours, in decimal form, Rachel worked on Monday 10th March.
b Determine how many unpaid breaks Rachel took.
c Calculate the total number of hours Rachel worked for the fortnight.

WORKING	THINKING
a 5 h and 45 min $= 5 \text{ h} + \frac{45}{60}$ $= 5 \text{ h} + 0.75$ $= 5.75 \text{ h}$	Refer to the total hours for March 10 in the timesheet. On your calculator, use either the ÷ or fraction function to evaluate this answer.
b 5 unpaid breaks	Refer to the unpaid breaks column of the timesheet.
c 49 h and 45 min $= 49 \text{ h} + \frac{45}{60} \text{ h}$ $= 49 \text{ h} + 0.75 \text{ h}$ $= 49.75 \text{ hours}$	49 hours plus 45 divided by 60, as there are 60 minutes in 1 hour. On your calculator, use either the ÷ or fraction function to evaluate this.

Example 4 Calculating wages

a Rob is 16 years old and works at a local grocery store, earning $12.55 per hour. Calculate how much money he will earn when he completes a 5-hour shift.
b Maree is 15 years old and employed at the Beach House Café on a casual basis. She earns $11.76 per hour. Calculate how much money she will earn if she completes a shift lasting for 7 hours and 15 minutes.
c Maureen worked for 6 hours at the local bowling alley. She was paid a total of $85.26. Determine Maureen's hourly rate of pay.

WORKING	THINKING
a $\$12.55 \times 5 = \$62.75$ Rob's income for this shift is $62.75.	Rob earns $12.55 per hour. Rob worked for 5 hours, so multiply his hourly rate by the number of hours worked.
b 7 h and 15 min $= 7 + \frac{15}{60} = 7.25 \text{ h}$ $\$11.76 \times 7.25 = \$85.26$ Maree's income for this shift was $85.26.	Maree worked for 7 hours and 15 minutes. Convert minutes to decimal hours by dividing by 60. Maree earns $11.76 per hour. Multiply the hourly rate by the number of hours worked.
c $\$85.26 \div 6 = \$14.21$ per hour Maureen was paid $14.21 per hour.	Maureen earned a total of $85.26 for 6 hours of work. Divide the total amount earned by the number of hours worked to calculate the amount she was paid per hour.

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Exercise 8A

FUNDAMENTALS

1 Demonstrate your understanding of terms by filling in the missing words in the following statements.

- **a** When a person is _____, they earn money from a job.
- **b** An _____ is the title given to the person who is the employed worker.
- **c** An _____ is the person who owns or manages the business.
- **d** Per annum (__. __) means per _____.
- **e** People who are paid a fixed annual income earn a _____.
- **f** People who are paid per hour earn a _____.
- **g** Income earned **before** tax is taken out is called _____ ____.
- **h** Income earned **after** tax is taken out is called _____ ____.

2 Identify the meaning of each word in the left column (**A** to **L**) from the definitions in the right column (**a** to **l**).

A	employee	**a**	An amount above your normal hourly rate that is paid when you work extra hours
B	salary	**b**	For the total of a year
C	wage	**c**	Rates that apply on a weekend or public holiday and pay per hour is increased
D	per annum	**d**	An agreed yearly income, regardless of the amount of hours worked
E	overtime	**e**	A person who is paid to work for a company or organisation or business owner
F	timesheet	**f**	An individual record of the amount paid, tax withheld and any other deductions for a payment period
G	employed	**g**	The amount of money earned after allowed deductions
H	employer	**h**	Amount of money earned in total before any deductions
I	payslip	**i**	A record to keep track of the number of hours someone has completed so that they can be paid for each hour
J	net income	**j**	To have a paying job
K	penalty rates	**k**	An income paid on an hourly basis
L	gross income	**l**	The company or organisation or business owner who employs and pays their workers

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3 From the list below, categorise each option into a table, similar to the one shown, according to whether it applies to a wage or a salary or both.

Wage	Salary

Overtime	Casual	Hourly rate of pay
Payslip	Income	Paid annual leave
Set annual amount	Penalty rates	Timesheet
Allowances	Regular set income per pay	Paid sick leave

4 For the following time periods, calculate the number of hours, stating the result in decimal form, where applicable.

a 8 a.m. to 3 p.m.
b 11 p.m. to 10 a.m.
c 7:30 a.m. to 12:30 p.m.
d 9:30 a.m. to 4 p.m.
e 1:30 p.m. to 8 p.m.
f 6:15 a.m. to 1 p.m.
g 12:30 p.m. to 7:15 p.m.
h 10:45 p.m. to 6 p.m.
i 9 a.m. to 3:15 p.m.
j 12:30 p.m. to 8:15 a.m.

5 For each of the following, the length of the shift and the hourly rate of pay is given. Calculate the amount earned for the shift.

Hint: Whole hours + $\frac{\text{minutes}}{60}$

a 5 hours at $16.33 per hour
b 9.25 hours at $21.45 per hour
c 6.75 hours at $29.88 per hour
d 8 hours at $19.22 per hour
e 9.5 hours at $29.50 per hour
f 4.25 hours at $21.52 per hour
g 6.2 hours at $20.28 per hour

A 17-year old employee's wage is 60% of the adult pay rate but increases to 70% on their 18th birthday.

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APPLICATIONS

SF: 6–13 | CF: – | CU: –

Example 1 ★6 Refer to the image of Wayne's payslip below and answer the following questions.

Employee Payslip – Pay Period: 01/04/2019

Pay Component	Hours	Salary Code	Hourly Rate	Amount
ORD CASUAL	74		$21.90	$1620.60

Name: Wayne Smart
Address: 18 Cicade Street
Harvey Bay 4655

Gross	$1620.60	Tax	$234.00	Net:	$1386.60
YTD Gross	$33 852.95	YTD Tax	$4734.35	YTD Net:	$29 118.60

Accrued Annual Leave (Hours): 0

Banking details:	Amount
QLD Bank a/c 18749	$1386.60

Superannuation	Amount
Worker Super	$153.96

a Decide whether you think that Wayne is paid a salary or a wage.
b Identify how many hours Wayne worked over the past two weeks.
c Identify Wayne's hourly rate of pay.
d Identify his total gross pay (i.e. before tax is taken out) for the two weeks.
e Identify his total net pay (i.e. the amount he receives in his bank account).

★7 Refer to Hayley's February payslip and answer the following questions.

MiniMe Jewellery Designs
ABN: 330713567914500

Name: Hayley Susanne
Address: 5 Conroy Street Kureelpa 4560

Pay Period from 6/5/19–20/5/19 Employee ID: 1788

Pay Type: Full-time Permanent		**Annual Income:** $49,103.60
Hours: 76	**Hourly Rate:** $24.85	**Amount:** $1888.60

Gross: $1888.60
Tax: $326.00
Net: $1,562.60

YTD Gross: $39,660.30
YTD Tax: $6,846.00
YTD Net: $32,814.30

Banking details: Bank4you a/c 98356 Amount $1,562.60
Accrued Annual Sick Leave: 114 hours as of 20/5/19
Accrued Sick Leave: 28.5 hours as of 20/5/19
Superannuation: Savers Super **Amount:** $179.42

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a Decide whether Hayley earns a salary or a wage.
b Identify the number of hours that Hayley is paid for.
c Identify Hayley's gross fornightly income.
d Identify how much tax Hayley has paid this financial year so far.
e Given that there are 26 fortnights in a year, calculate Hayley's annual net income.

Example 2 ★8 Harrison is paid $27.50 per hour working part-time at the local library and his contract states that he is paid for his breaks. His roster for this week is shown.

a Calculate how many hours he will work this week.
b Determine his total income for the week.

Day	Start	Finish
Monday	8 a.m.	1 p.m.
Tuesday	9 a.m.	5:15 p.m.
Wednesday	8 a.m.	1:30 p.m.
Thursday	–	–
Friday	–	–
Saturday	9:30 a.m.	12:30 p.m.

Hint Add the number of hours and minutes separately.

Example 3 ★9 Refer to the image of Noah's timesheet and answer the following questions.

TIMESHEET **Study the Waves, Surf School Aus.**

Employee's name: Noah Tuker

School Location: Burleigh Heads

Period (date/month/year): 27/12/2018 to 10/1/2019 **Pay date (date/month/year):** 11/1/2019

Type of employment: Casual

Day/Date	Start time	Finish time	Unpaid breaks	Total hours (minus unpaid breaks)
Thursday 27/12/18	6 a.m.	11 a.m.	Nil	5 h
Friday 28/12/18	6 a.m.	5 p.m.	1 h	10 h
Saturday 29/12/18	7 a.m.	11 a.m.	Nil	4 h
Thursday 3/1/19	6 a.m.	5 p.m.	1 h	10 h
Friday 4/1/19	8 a.m.	11 a.m.	Nil	3 h
Monday 7/1/19	6 a.m.	12 p.m.	30 min	5 h 30 min
Wednesday 9/1/19	7 a.m.	11 p.m.	Nil	3 h
			TOTAL	

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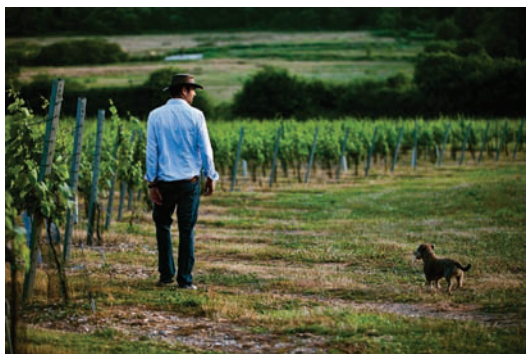
a Identify the number of hours Noah worked on Thursday 3rd January.
b Determine how many unpaid breaks Noah took during this fortnight.
c Calculate the total hours Noah worked during the fortnight.

Example 4 ★**10** Wilhelmina works casual hours after school at the Eco Café. She completes a total of 14 hours this week and is paid $13.75 per hour. Calculate her wage for the week.

★**11** Lachlan works long hours on a vineyard, where he earns $31.80 per hour. If he completes a shift that is 11 hours and 30 minutes, calculate how much he will earn for the day.



★**12** Use the image of Kelly's payslip to answer the following questions.

Name: Kelly McKbuckby — Tutoring4Life

Address: 9 First Street Kingaroy 4610 — ABN: 19886537270879

Pay Type: Casual Ord		**Pay Period from 6/5/19–13/5/19**
Hours: 37.5	**Hourly Rate:** $21.50	**Amount:**

Gross: $ _____ YTD Gross: $29,347.50
Tax: $115.00 YTD Tax: $3,948.00
Net: $ _____ YTD Net: $25,399.50

Annual Sick Leave: 0 hours
Superannuation: Sky Super **Amount:** $76.59

a Identify Kelly's per hour income.
b Identify how many hours Kelly worked this week.
c The total gross income for the week is missing. Calculate how much Kelly should earn this week as her gross income.
d Given that Kelly was taxed $115.00, calculate her net income for the week.

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★13 Jack works at a local hardware store. Shown is his timesheet for his completed hours over the past week.

TIMESHEET

Employer's name: Hardware Experts

Employee's name: Jack Pinkster

Period (date/month/year): 28/2/2019 to 14/3/2019

Pay date (date/month/year): 15/3/2019

Type of employment: Part Time

Day/Date	Start time	Finish time	Unpaid breaks	Total hours (minus unpaid breaks)
Thursday 28/2/19	7 a.m.	11:30 a.m.	Nil	i
Friday 1/3/19	12 p.m.	6 p.m.	30 min	ii
Saturday 2/3/19	10 a.m.	5 p.m.	30 min	iii
Tuesday 5/3/19	9 a.m.	5 p.m.	1 h	iv
Wednesday 6/3/19	8 a.m.	2 p.m.	v	5 h 30 min
Friday 8/3/19	6 a.m.	12 p.m.	30 min	vi
Monday 11/3/19	10 a.m.	2 p.m.	Nil	vii
			TOTAL	viii

a Calculate the missing information (**i** to **viii**) from the timesheet.

b Given that Jack earns $23.48 per hour, but he does not get paid for his lunch break, calculate his total income for the week.

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8B Wages and Overtime

LEARNING GOALS

- Understand the purpose and real-life applications of overtime
- Apply the multiplication factors for the following overtime calculations:
  - time and a half (1.5×)
  - double time (2×)
  - double time and a half (2.5×)
- Convert hours worked using penalty rates
- Convert hourly pay rate using penalty rates

When is overtime applied?

Overtime is when a person works more than their usual paid hours within a day or week. Some employers pay a penalty rate to their employees, depending on their contract. Overtime can be paid at time and a half or double time of the employee's usual pay rate.

A firefighter's wage is calculated at an hourly rate, which is increased for overtime, shift work and public holidays.

WHAT YOU NEED TO KNOW

- **Overtime** rates apply when an employee works more than the normal or agreed number of hours, for example, 8 hours/day or 38 hours/week.
- **Penalty rates** apply on a weekend or public holiday and pay per hour is increased.
- **Time and a half** is 1.5 times the employee's usual pay rate and is equivalent to 1.5 times the number of hours worked.
- **Double time** is twice the employee's usual rate of pay or equivalent to twice the number of hours worked.
- **Double time and a half** is 2.5 times the employee's usual pay rate and is equivalent to 2.5 times the number of hours worked.

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- Penalty rates also can be calculated based on a percentage increase. For example, if a casual employee working in hospitality on a Sunday earns 175% of their hourly base pay rate, then their base pay rate would be multiplied by the percentage divided by 100:

$$\$18.80 \times \frac{175}{100} = \$32.90 \text{ per hour}$$

Example 5 Converting hours worked, according to penalty rates

Calculate the number of hours to be paid at the normal rate per hour, given that the penalty rate in brackets applies.

a 7 hours (time and a half)

b 6.5 hours (double time)

c 9 hours (double time and a half)

WORKING	THINKING
a $7 \times 1.5 = 10.5$ hours	Time and a half is 1.5 × the hours worked.
b $6.5 \times 2 = 13$ hours	Double time is 2 × the hours worked.
c $9 \times 2.5 = 22.5$ hours	Double time and a half is 2.5 × the hours worked.

Example 6 Converting hourly pay rate, according to penalty rates

Convert the following normal hourly rates to their equivalence, given that the penalty rate in brackets applies.

a $19.48 (time and a half)

b $24.72 (double time)

c $13.28 (double time and a half)

WORKING	THINKING
a $19.48 \times 1.5 = \$29.22$ per hour	Time and a half = 1.5 × normal hourly rate. This is the rate of pay per hour for any hours worked at time and a half.
b $24.72 \times 2 = \$49.44$ per hour	Double time = 2 × normal hourly rate. This is the rate of pay per hour for any hours worked at double time.

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WORKING	THINKING
c $13.28 \times 2.5 = \$33.20$ per hour	Double time and half $= 2.5 \times$ normal hourly rate. This is the rate of pay per hour for any hours worked at double time and a half.

Example 7 Calculating a wage with penalty rates in a real-world situation

Priya works part-time at a fast-food store. She earns $13.45 per hour. On Australia Day she worked 7 hours and received penalty rates at double time for the whole shift. Calculate Priya's wage for working on Australia Day.

WORKING	THINKING
Wage $= \$13.45 \times 7 \times 2$ $= \$188.30$ Priya earned $188.30 for the day.	Multiply the hourly rate by the number of hours, then multiply by 2 for double time for the penalty rate.

Example 8 Calculating penalty rates using a percentage increase

Ken completed an 8-hour shift on a public holiday, waiting tables at the Lotus Flower Thai restaurant. His base pay rate is $21.70 per hour and the penalty rate for working on a public holiday is 160%. Calculate Ken's total income for the day.

WORKING	THINKING
$\$21.70 \times \frac{160}{100} = \$34.72$ per hour	Calculate the increased hourly amount by multiplying Ken's base rate by the percentage penalty rate divided by 100.
8 hours $\times$ $34.72 = $277.76	Multiply the total number of hours worked by the increased hourly amount.

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Example 9 Calculating overtime pay in a real-world situation

Jasmine earns $20.68 per hour and she worked four shifts this week. Each shift was intended to be 8 hours long. If Jasmine works more than 8 hours per shift, she is paid a penalty rate of time and a half for the extra time.
Fill in the missing information (**a** to **e**) on Jasmine's timesheet.

TIMESHEET						**Name: Jasmine Smith**
Day	**Start**	**Finish**	**Total hours**	**Normal hours**	**Overtime**	**Earnings**
Monday	8 a.m.	4 p.m.	8 h	8 h	–	**a**
Tuesday	8 a.m.	5 p.m.	9 h	8 h	**b**	**c**
Wednesday	–	–	–		–	–
Thursday	7 a.m.	4:30 p.m.	9 h 30 min	8 h	1 h 30 min	**d**
Friday	8 a.m.	4 p.m.	8 h	8 h	–	$165.44
		TOTAL	34 h 30 min	32 h	2.5 h	**e**

WORKING	**THINKING**
a $8 \times \$20.68 = \$165.44$	On Monday Jasmine worked 8 hours, so no overtime.
b $9\text{h} - 8\text{h} = 1\text{h}$	Overtime is the number of hours worked above 8 hours. Subtract 8 hours from the hours worked.
c $\$165.44 + (1 \times \$20.68 \times 1.5) = \$196.46$	8 hours at normal pay rate is $165.44 (from part **a**) plus 1 hour at the pay rate multiplied by penalty rate of time and a half.
d $\$165.44 + (1.5 \times \$20.68 \times 1.5) = \$211.97$	8 hours at normal pay rate is $165.44 (from part **a**) plus 1 hour 30 minutes (1.5 hours) at the pay rate multiplied by penalty rate of time and a half.
e $\$165.44 + \$196.46 + \$165.44 + \$211.97 = \$739.31$	Add together daily earnings to calculate total gross income for the week.

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Exercise 8B

FUNDAMENTALS

1 Demonstrate your understanding of terms by filling in the missing words in the following statements.

- **a** When an employee works more than the normal number of hours, _____ rates apply.
- **b** Double time is _____ the employee's usual rate of pay.
- **c** _____ and a _____ is 1.5 times the employee's usual pay rate.
- **d** _____ rates apply when working on weekends or public holidays.

Example 5

2 Calculate the number of hours to be paid at the normal rate per hour, given that the penalty rate in brackets applies.

- **a** 8 hours (time and a half)
- **b** 4 hours (double time and a half)
- **c** 6 hours and 30 minutes (double time)
- **d** 5 hours 30 minutes (time and a half)
- **e** 10 hours 15 minutes (double time)
- **f** 7 hours 30 minutes (double time and a half)

Example 6

3 Calculate the equivalent hourly rate, given that the penalty rate in brackets applies.

- **a** $14.38 (time and a half)
- **b** $11.72 (double time)
- **c** $23.28 (double time and a half)
- **d** $21.36 (time and a half)
- **e** $16.40 (double time)
- **f** $18.94 (double time and a half)

4 Paul works in accounts for a real estate company. He earns a wage of $31.70 per hour. Calculate Paul's hourly rate of pay when the following penalty rates apply.

- **a** time and a half
- **b** double time
- **c** double time and a half

5 Mason is employed to work 8 hours per shift. If he works any longer than this during a shift, the extra hours are considered to be overtime. Calculate how many hours overtime Mason has worked in each of the following shifts.

- **a** 8 a.m. to 4:30 p.m.
- **b** 12 p.m. to 9.30 p.m.
- **c** 11 a.m. to 8:45 p.m.
- **d** 7:30 a.m. to 3:45 p.m.
- **e** 9 p.m. to 7 a.m.
- **f** 5 p.m. to 1:45 a.m.

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APPLICATIONS

SF: 6–15	CF: –	CU: –

Example 7 ★6 Peter is employed to run 4WD tours on Fraser Island. His normal pay rate is $25.70 per hour. The busiest day of the year is Australia Day, so Peter typically works a 12-hour shift. Peter's company pays him a double time penalty rate for the whole Australia Day shift. Calculate Peter's income on Australia Day.

★7 Jan, a gardener, is asked to work with a client for 8 hours to set up a new vegetable patch on their land. The only day her client has available falls on Labour Day. Jan agrees to work on the public holiday, under the condition that she will be paid a penalty rate of time and a half. Given that she normally charges $28.50 per hour, calculate Jan's earnings on Labour Day.

★8 Sage works at a 24-hour emergency vet centre, earning $19.80 per hour. She has been rostered to work for 7.5 hours on Christmas Day, which carries a penalty rate of double time and a half. Calculate Sage's total wage for completing this shift.

★9 Cerek earns $14.74 per hour working after school for a gym. His contract states that if he works over his rostered hours in a week, he will receive an overtime penalty rate at time and a half. If Cerek works 4 hours overtime in a particular week, calculate how much money he will earn for these 4 hours.

★10 Jaleesa earns $29.40 per hour for a standard 40-hour work week. She earns time and a half for every hour worked over 40 hours. If Jaleesa works a 46-hour week, calculate her total earnings.

★11 Quentin works for Kids-R-Us and earns $18.90 per hour. He normally works for 38 hours per week and for every hour over this he is paid a rate of time and a half. During stocktake, staff must work really long hours, so for anything above 44 hours in a week, they are paid double time. Shown at right is Quentin's records of the number of hours he has worked over the past week of stocktake.

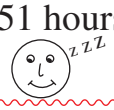
Calculate Quentin's income for the week.

Stocktake Hours

Mon → 12 hours
Tue → 8 hours
Wed → 10 hours
Thurs → 12 hours
Sat → 6 hours @ Time & half (yay)
→ 6 x 1.5 = 9 hours

$$\begin{array}{r} {\scriptstyle 2} \\ 12 \\ 12 \\ +\ 10 \\ 8 \\ 9 \\ \hline 51 \end{array}$$

= 51 hours



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Example 8 ★12 Abdul works in a sporting store and completes a 7-hour shift on a Sunday. His base pay rate is $18.60 per hour and on a Sunday his penalty rate is 185%. Calculate Abdul's income for the day.

★13 Ivanna is a full-time student who works part-time in a fast-food outlet. She typically earns $17.40 per hour. When she works more than her assigned hours per week, she is paid a penalty rate of 145%. In a particularly busy week, Ivanna works 7 hours and 30 minutes more than her rostered hours. How much extra will Ivanna receive in her pay?

Example 9 ★14 Karl earns $25.70 per hour as a camp coordinator. When he works on the weekend, he is paid a penalty rate of time and a half. Calculate the missing hours (**a** to **d**) on his timesheet below.

TIMESHEET

Employer's name: Karl Williams

Employee's name: Explored Adventures

Period (date/month/year): 27/6/2019 to 11/7/2019 **Pay date (date/month/year):** 11/7/2019

Day/Date	Start time	Finish time	Unpaid breaks	Overtime	Total equivalent hours (minus unpaid breaks)
Thursday 27/6/19	8 a.m.	1 p.m.	Nil	–	5 h
Friday 28/6/19	6 a.m.	3 p.m.	1 h	–	8 h
Saturday 29/6/19	7 a.m.	12 p.m.	Nil	5 h × 1.5 = 7.5 h	7.5 h
Monday 1/7/19	6 a.m.	5 p.m.	1 h	–	10 h
Tuesday 2/7/19	7 a.m.	12 p.m.	Nil	–	5 h
Thursday 4/7/19	6 a.m.	12 p.m.	30 min	–	5.5 h
Sunday 7/7/19	7 a.m.	12 p.m.	Nil	**a**	**b**
			TOTAL	**c**	**d**

★15 Eden earns $36.20 per hour as a casual nurse. She worked five shifts this week, where each shift is supposed to be 8 hours long. If Eden works longer than this, she is paid a penalty rate of time and a half for the extra time worked. Calculate the missing hours or earnings (**a** to **k**) on Eden's timesheet below.

TIMESHEET **Name: Eden Chang**

Day	Start	Finish	Total hours	Normal hours	Overtime	Earnings
Monday	7 a.m.	4 p.m.	9 h	8 h	1 h	**a**
Tuesday	8 a.m.	4:30 p.m.	8 h 30 min	8 h	**b**	**c**
Wednesday	12 p.m.	9:45 p.m.	**d**	8 h	**e**	**f**
Thursday	9 a.m.	6:15 p.m.	9 h 15 min	8 h	1 h 15 min	**g**
Friday	–	–	–	–	–	–
Saturday	7 a.m.	3 p.m.	**h**	8 h	0	$289.60
		TOTAL	**i**	40 h	**j**	**k**

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8C Income by piecework and commission

LEARNING GOALS

- Calculate income from commission
- Calculate income from piecework
- Calculate piecework rates

What is essential to know about piecework and commission?

Earning an hourly wage is not the only way individuals can earn an income. Piecework provides an income by paying a certain amount per item produced or 'piece' of work completed. Commission is paid as a percentage of sales, such as commission paid to a real estate agent or car salesperson.

Fruit pickers are usually paid by piecework, where each 'piece' of work is a bin or box of picked fruit.

WHAT YOU NEED TO KNOW

- Payment systems that do not depend on the time taken are piecework, commission and retainers.
- **Piecework** is a system of payment where the worker is paid for each 'piece' of work they complete. It can be for a specified number of items produced or tasks done.
  - For example: paid per cake made (i.e. per item) or per bin of fruit picked (i.e. per task).
- **Commission** is a system of payment based on a percentage of sales. Sometimes this type of employment also has a retainer.
  - For example, real estate agents paid 2% commission of the selling price of a house.
- A **retainer** is like a salary paid to an agent or salesperson, as it is a set amount of money per week, fortnight or month.
  - For example, an advertisement for a car sales job may state: 'This position offers a retainer of $45k and a generous commission structure.'

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- Change percentages to a decimal number by dividing by 100.
  - For example: $4.25\% = \frac{4.25}{100} = 0.0425$

    $8\frac{3}{4}\% = \frac{8.75}{100} = 0.0875$
- **Review of the rules when rounding decimal places**

  For money calculations, round the final result to the nearest cent; that is, round to two decimal places. If the third decimal place is:
  - 5 or higher, then round the second decimal place up by 1
  - less than 5, then round down by keeping the second decimal place the same.
  - For example: \$64.837 rounds up to \$64.84.

    \$37.264 rounds down to \$37.26.

Example 10 Working with percentages [Review]

Calculate the following.

a 8% of \$23 000 **b** 12.5% of \$76 300

WORKING	THINKING
a $\frac{8}{100} = 0.08$ $0.08 \times \$23\,000 = \$1840$	$8\% = \frac{8}{100} = 0.08$
b $\frac{12.5}{100} = 0.125$ $= 0.125 \times \$76\,325$ $= \$9540.625$ $= \$9540.63$	$12\frac{1}{2}\% = \frac{12.5}{100} = 0.125$ The third decimal place is 5, so round 0.625 up to 0.63.

Example 11 Calculating income from commission

Gina is a real estate agent. She receives a retainer of \$600 per week and earns 2.25% commission on the sale of each house. One week she sold a property for \$410 000. Calculate her gross income for that week.

WORKING	THINKING
$\frac{2.25}{100} = 0.0225$	Convert 2.25% to a decimal by dividing by 100.
$0.0225 \times \$410\,000 = \$9225$	Multiply this by the price of the property.
$\$9225 + \$600 = \$9825$	Add the retainer to the commission.

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Example 12 Calculating income from piecework

a Cian earns an income through piecework. He works as a shearer and is paid $3.10 for each sheep. If Cian shears 214 sheep in a day, calculate how much he will earn.

b Willem is a backpacker working in Far North Queensland, picking fruit. He is paid $12.97 per bin. Calculate his income if he fills 17 bins of fruit.

WORKING	THINKING
a $214 \times \$3.10 = \$663.40$ Cian's income is $663.40.	Multiply the number of sheep by the amount per sheep.
b $17 \times \$12.97 = \$220.49$ Willem's income is $220.49.	Multiply the number of bins by the rate of pay per bin.

Example 13 Calculating a piecework rate

If Emma is paid $577.50 by a market supplier for making 110 jars of facial scrub, how much is she paid per jar?

WORKING	THINKING
$\$577.50 \div 110 = \$5.25$	$577.50 divided by 110 tells you how many times 110 goes into the total amount, which calculates the cost per bottle.

Exercise 8C

FUNDAMENTALS

1 Demonstrate your understanding of terms by filling in the missing words in the following statements.

a Piecework, commission and retainers are payment systems that do ____ depend on the time taken to complete the task.

b A _____ is when a set amount of money is paid per week, fortnight or month, regardless of sales made or the hours worked.

c _____ is when the worker is paid for a specified number of items produced or certain tasks completed.

d _____ is a system of payment based on a percentage of sales.

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Example 10

2 Calculate each of the following.

a 5% of $7000 **b** 12% of $13 578 **c** 7.8% of $44 500
d 1.85% of $395 782 **e** 7.83% of $46 784 **f** 14.7% of $32 583
g 7.5% of $38 500 **h** 5.25% of $40 000 plus 2% of $180 000

3 Doug works in a bike store and is paid 3% commission for every bike sold. Calculate how much he would earn in commission on each of the following sales.

a $8900 **b** $13 499 **c** $21 700

4 Pam is paid $2.00 for every small crocheted item that she makes for a local baby store. Calculate the amount she would earn if she crocheted these number of items.

a 15 **b** 25 **c** 32
d 56 **e** 107 **f** 371

APPLICATIONS

SF: 5–20 | CF: – | CU: –

Example 11

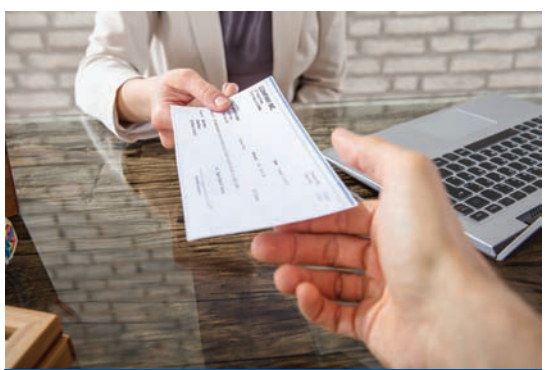
★5 Griffin is a computer salesperson who earns 12% commission on any sales. Calculate the amount of commission he will earn if he sells $18 960 worth of computers.

★6 Melanie works for an arts and craft supplier and is paid 14% commission on any sales that she makes. Calculate her weekly income if she sells the following amounts of goods.

a $2764 **b** $3219.65 **c** $4199.80 **d** $6052.35

★7 Ashley is an independent livestock broker who earns 5% commission for the sale of livestock. Calculate his earnings if he sells 90 head of cattle for a total of $108 000.

★8 Madison is a salesperson for a large hair and beauty products company. She is paid a retainer of $800 per week plus 7.5% commission on her sales of hair products. If Madison sells $3674 worth of stock in a particular week, what are her total earnings?



Wages may be paid by cash, cheque or electronic funds transfer.

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★9 Brad works as an insurance salesperson and earns a retainer of $3335 per month plus commission of 4% on any insurance products he sells. Calculate Brad's income for the month if he sells $24 570 worth of products that month.

★10 Renee sells Kapture Cameras to retail outlets. She is required to run workshops that educate the retail sales staff on the features of the various cameras. She earns a retainer of $517 per week plus a commission of 3.95% on sales, and she is paid a bonus $70 for each training workshop she runs. One week, she sells $8984 worth of cameras and runs three training workshops. Calculate her income for that week.

★11 Loki is a real estate agent and is paid a retainer of $680 per week plus 2.1% commission for every house he sells. Calculate Loki's earnings for the week when he sells a unit for $330 000.

Example 12 ★12 Bronte is a seamstress. She is paid $14 per dress hem that she sews. Calculate Bronte's income if she completes 35 dress hems in three days.

★13 Scott is a carpet cleaner who is paid $27.00 per room that he completes. Calculate the amount he earns if in one day he cleans nine rooms.

★14 Giulia works in a busy city as a bicycle courier. She is paid $6.85 per kilometre that she cycles along her parcel delivery route. Calculate Giulia's earnings if she travels 22 km in a day.

★15 Billy works as an Uber driver and is paid $6.95 per food delivery. Calculate his earnings if he delivers orders to 16 households in 3.5 hours.

★16 Lorna details cars for Von Wagons. She is paid $14.40 for each car that she details (i.e. cleans and polishes). Calculate her daily income when she details 17 cars in one day.

17 Harley delivers catalogues and pamphlets to households for $28.00 per lot of 1000. For each of the following number of deliveries:

i How many lots of 1000 are there?

ii Calculate Harley's income.

a 8000 b 12 000 c 13 500

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★18 Dena owns a laundromat in Mooloolaba. She has an advertised special where she charges $31 per basket of ironing. Calculate Dena's income if she completes 36 baskets of ironing in a week.

Example 13 ★19 If Ricka is paid $299.25 for having knitted 21 scarves, calculate her income per piece.

★20 If Hendrix is paid $361.90 for performing 47 songs at an event, calculate his cost per song.

PROBLEM-SOLVING

★21 Justine bakes individual items for a popular bakery. She makes a variety of cakes and pastries for them and is paid various amounts, depending on the item. Shown is a list of the prices she charges for each item. During the past week, the bakery purchased the following items. Calculate Justine's weekly income for that week.

Bakery's order	Justine's price list	
110 cupcakes	apple turnover	$1.30
90 apple & walnut slices	apple & walnut slice	$0.95
35 caramel slices	bacon scroll	$1.25
35 vanilla slices	caramel slice	$0.85
50 veggie scrolls	carrot cake	$20.00
70 bacon scrolls	croissant	$0.80
60 apple turnovers	cupcake	$1.80
50 scones (mixed)	gluten-free mud cake	$20.00
140 croissants	scones (mixed)	$0.80
2 gluten-free mud cakes	vanilla slice	$1.10
2 carrot cakes	veggie scroll	$1.25

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8D Converting income between various time periods COMPLEX

LEARNING GOALS

- Convert annual income to weekly, fortnightly and monthly income
- Convert weekly income to annual, monthly and fortnightly income
- Convert monthly income to annual, weekly and fortnightly income
- Convert hourly income to annual, weekly and fortnightly income

When does an individual convert their income between various time periods?

Individuals must convert their income (pay) according to various time periods in order to check their hourly rate of pay or to calculate their annual income. This can help when checking timesheets and payslips, and is also crucial for budgeting. This conversion also helps individuals compare the various pay rates of different jobs and positions.

WHAT YOU NEED TO KNOW

- Multiples of time periods that give 1 year

365 days = 1 year
52 weeks = 1 year
26 fortnights = 1 year
12 months = 1 year

- Converting annual income to weekly, fortnightly and monthly income

Annual income ÷ 52 = weekly income
Annual income ÷ 26 = fortnightly income
Annual income ÷ 12 = monthly income

- Converting weekly, fortnightly and monthly income to annual income

Weekly income × 52 = annual income
Fortnightly income × 26 = annual income
Monthly income × 12 = annual income

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- Converting weekly pay to monthly pay requires two calculations. First calculate the annual pay, then the monthly pay.

  Weekly pay × 52 = annual pay
  Annual pay ÷ 12 = monthly pay

- Converting monthly pay to weekly pay requires two calculations. First calculate the annual pay, then the weekly pay.

  Monthly pay × 12 = annual pay
  Annual pay ÷ 52 = weekly pay

- It is a common misconception that there are 4 weeks per month. All months, except February, have more than 4 weeks, as 4 weeks is only 28 days and there are either 30 or 31 days in every other month. In financial calculations it is important to be accurate and follow the time conversion procedures given.
- Converting hourly pay to weekly pay requires multiplying the hourly pay by the number of working hours in a week, e.g. 35 hours per week (7 hours a day × 5 workdays in a week). Then convert weekly pay to fortnightly pay by multiplying by 2, and convert weekly pay to monthly pay or annual pay using the methods above.

Example 14 Converting annual income to weekly, fortnightly and monthly income

Paul is a first-year police officer who works full-time and earns a salary of $70 820 per annum.

a Calculate his weekly income.
b Calculate his fortnightly income.
c Calculate his monthly income.

WORKING	THINKING
a $70 820 ÷ 52 = $1361.923	Annual income ÷ 52 = weekly income
= $1361.92 per week	Round the answer to two decimal places.
b $70 820 ÷ 26 = $2723.846	Annual income ÷ 26 = fortnightly income
= $2723.85 per fortnight	Round the answer to two decimal places.

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WORKING	THINKING
c $70 820 ÷ 12 = $5901.666	Annual income ÷ 12 = monthly income
= $5901.67 per month	Round the answer to two decimal places.

Example 15 Converting weekly income to annual, monthly and fortnightly income

Stacey works as a learning support assistant. She earns $806.38 per week.

a Calculate her fortnightly earnings.

b Calculate her annual earnings.

c Calculate her monthly earnings.

WORKING	THINKING
a $806.38 × 2 = $1612.76 per fortnight	Weekly income × 2 = fortnightly income
b $806.38 × 52 = $41 931.76 p.a.	Weekly income × 52 = annual income
c $41 931.76 ÷ 12 = $3494.313 = $3494.31 per month	Annual income ÷ 12 = monthly income

Example 16 Converting monthly income to annual, fortnightly and weekly income

Ivan works full-time at an aged care facility as a nursing assistant. He earns $3737.93 per month.

a Calculate his weekly earnings.

b Calculate his fortnightly earnings.

WORKING	THINKING
a $3737.93 × 12 = $44 855.16 p.a.	Monthly income × 12 = annual income
$44 855.16 ÷ 52 = $862.599 = $862.60 per week	Annual income ÷ 52 = weekly income

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WORKING	THINKING
b $\$3737.93 \times 12 = \$44\,855.16$ p.a.	Monthly income × 12 = annual income
$\$44\,855.16 \div 26 = \$1725.198$	Annual income ÷ 26 = fortnightly income
$= \$1725.20$ per fortnight	The third decimal place is 8, which is greater than 5. So round up 9 to 10 and then 1 to 2, giving 0.20 as the decimal.

Example 17 Converting hourly income to annual, weekly and fortnightly income

Allen works as a farmhand for an average of 40 hours per week. He earns a wage of $21.68 per hour.

a Calculate his weekly income.
b Calculate his monthly income.
c Calculate his fortnightly income.

WORKING	THINKING
a $\$21.68 \times 40 = \$867.20$ per week	Hourly rate × 40 hours = pay per week
b $\$867.20 \times 52 = \$45\,094.40$ p.a.	First calculate the annual pay, then the monthly pay. Round the answer to two decimal places.
$\$45\,094.40 \div 12 = \$3757.866$	
$= \$3757.87$ per month	
c $\$867.20 \times 2 = \$1734.40$ per fortnight	Weekly income × 2 = fortnightly income

Exercise 8D

FUNDAMENTALS

1 Demonstrate your understanding of terms by filling in the missing words and numbers in the following statements.

a ____ days = 1 year
b ____ weeks = 1 year
c ____ fortnights = 1 year
d To convert weekly pay to monthly pay, first × ___ to find _____ pay, then ÷ ___ to find _____ pay.
e To convert monthly pay to weekly pay, first × ___ to find _____ income, then ÷ ___ to find the _____ income.

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2 The table shows various weekly incomes.

a Calculate the estimated monthly income by multiplying the weekly income by 4, to complete the second column.

b Calculate the actual monthly income (i.e. the third column) by first multiplying by 52 to find the annual income, then dividing by 12.

c Which is greater: the actual monthly income or the estimated monthly income? Explain why.

Weekly income	Estimated monthly income	Actual monthly income
$475.80		
$960.75		
$1178.95		
$1510.80		

Example 14 **3** Fatima works in childcare and earns $52 000 p.a. Calculate her income per:

a week **b** fortnight **c** month

Example 15 **4** Don works as a hospital orderly and earns $1023 per week. Calculate his income per:

a fortnight **b** year **c** month

Example 16 **5** Marion is a home-care worker and earns $3212.80 per month. Calculate her income per:

a year **b** week **c** fortnight

Example 17 **6** Scott is an apprentice plumber and works 27 hours per week and earns $21.23 per hour. Calculate his income per:

a week **b** fortnight **c** year **d** month

APPLICATIONS

SF: – | CF: 7–14 | CU: 15, 16

★**7** Jason is a long-haul truck driver, earning $5145.70 per month. Calculate his yearly income.

★**8** Antonia works as a nurse and earns a gross income of $65 748 p.a. If Antonia is paid on a fortnightly basis, calculate her gross income for each pay.

★**9** Dean works as an apprentice electrician. He earns $17.95 per hour and works 38 hours per week. Calculate his salary per annum if he works 48 weeks a year.

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★10 Amy works at Greenery Daycare. Refer to the her fortnightly payslip (shown below) to answer the following.

a Calculate Amy's yearly gross income.

b Calculate her yearly net income.

c Determine how much tax Amy pays each year.

Name: Amy Jones — Greenery Daycare

Address: 10 Bathurst Drive, Biggera Waters — ABN: 198865735386873

Pay Type: Casual Ord	Pay Period from 6/12/18–20/12/18	
Hours: 74	**Hourly Rate:** $22.45	**Amount:** $1661.30

Gross: $1661.30

Tax: $246.00

Net: $1415.30

Annual Sick Leave: 16.5 hours

Superannuation: SuperFirst — **Amount:** $157.82

Banking details: QueBank a/c 35678030 — Amount: $1415.30

★11 Jaxson works as a solicitor and last year he was paid $96 780. He estimated that, on average, he works 41 hours per week.

a Calculate Jaxson's weekly income.

b Calculate Jaxson's hourly pay.

★12 Chayse works 38 hours per week as a landscaper and is paid $54 241.20 per annum. Calculate his hourly earnings.

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★13 Kirra has just completed her Business Certificate and has been offered two positions. Balanced Accountancy is offering to pay her $45 730 p.a and We All Count Accountancy is offering her $1794.90 per fortnight. Both positions are 38 hours per week and have similar duties. Determine which position would pay Kirra the most amount of money.

★14 Tristan and Tamsyn are trying to compare their incomes. Tristan works in a sports store for 21 hours per week and is paid $17.65 per hour. Tamsyn works at a pet shop and earns $360 per week. Calculate who earns the most income.

★15 Shown is Rebecca's timesheet for her first fortnight at her new workplace. Her contract states that she will be paid $26.90 per hour and on Sundays she will earn time and a half.

a Calculate Rebecca's fortnightly income.

b Predict Rebecca's yearly income based on this timesheet.

TIMESHEET				**Name: Rebecca McCarthy**
Day	**Start**	**Finish**	**Total hours excluding break**	**Overtime**
Monday	8 a.m.	4 p.m.	7 h 30 min	0
Tuesday	8 a.m.	4:30 p.m.	8 h	0
Thursday	12 p.m.	8:30 p.m.	8 h	0
Friday	9 a.m.	6 p.m.	8 h 30 min	0
Sunday	8 a.m.	4 p.m.	7 h 30 min	$7.5 \times 1.5 = 11.25$
Monday	7 a.m.	3 p.m.	7 h 30 min	0
Wednesday	10 a.m.	3 p.m.	5 h	0
Thursday	10 p.m.	2 p.m.	4 h	0
Sunday	8 a.m.	1 p.m.	5 h	$5 \times 1.5 = 7.5$
		Total hours (including overtime)		67.25

★16 Miguel is arguing with his friend Sam about who earns the least. Sam, who is paid on a monthly basis and earns $4333.30 per month, is insisting that he earns less money than Miguel. Miguel insists he earns less money, as he is paid $1026.92 per week and therefore he believes he earns $4107.69 per month. Determine who earns the least amount of money and explain your process to solve the argument.

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8E Understanding taxation and superannuation

LEARNING GOALS

- Understand the purpose of taxation and superannuation
- Know the meaning of TFN (Tax File Number) and PAYG (Pay As You Go)
- Identify taxable income brackets and tax rates from the tax table
- Calculate an employer's superannuation contribution to an employee
- Identify information on a PAYG payment summary

What is the purpose of taxation and superannuation?

The main purpose of taxation is to raise money for the goods and services provided by the government. This includes, but is not limited to, the building of roads, parks, and hospitals, and also income support for community members. Superannuation is an effective way to save for your future retirement. For most employees, their employer must pay a set amount that is in addition to their normal salary or wage.

A plumber who is an employee will receive regular superannuation payments from his employer.

WHAT YOU NEED TO KNOW

- **Superannuation** is a personal investment account for use in retirement. The government has legislated that every employee receives 9.5% of their wage (in addition to their wage) deposited into one of the many available superannuation funds. Employees can make further contributions but the total per year is currently capped at $25 000. Self-employed individuals must also make superannuation contributions. Most super funds will let you choose a variety of investment options that range from high-risk to low-risk investment.

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- When do you qualify for a superannuation contribution?
  If your employer pays you more than $450 per month, they must contribute to your super fund. However, if you are under the age of 18 years or you are a private or domestic worker (e.g. a nanny), then you must also work a minimum of 30 hours per week to qualify for superannuation.
- **Tax** is money that is withheld (i.e. deducted) from your wage or salary and paid to the Australian Taxation Office (ATO) for all kinds of services, such as roads, hospitals, schools and defence. The government legislates the amount of tax that is regularly withheld from your income, based on your taxable income. Current tax rates can be found at https://www.ato.gov.au/Rates/Individual-income-tax-rates/
- A **Tax File Number** (**TFN**) is a personal reference number or identification number used in the tax and superannuation financial systems. It helps to keep records of your income and superannuation payments. Your TFN is yours for life; it does not change if you move interstate, overseas or you change your name. Having a TFN is not compulsory. However, if you do not have one you will pay more tax and cannot access any government benefits or hold an Australian Business Number (ABN). An ABN is required to run any Australian business. You can obtain a TFN through an application with the ATO.
- **Pay as you go (PAYG)** refers to paying tax 'as you go', meaning weekly, fortnightly or monthly, and is calculated on your expected annual income. It applies to you only when you earn an income over a certain amount. At the end of a financial year your employer will provide you with a PAYG summary, also called a group certificate, that shows you the amount of tax you have paid for that financial year.

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Example 18 Identifying tax on taxable income from the tax table

If the following amounts represent yearly taxable incomes, state how to calculate the tax on this income as given in column 2 of the table, by identifying the taxable income bracket (the row in the table) in which the amount lies.

a $18 199 **b** $22 550 **c** $87 100 **d** $210 500

Australian Taxation Office (ATO) Resident tax rates 2018–19

Taxable income	Tax on this income
0 – $18 200	Nil
$18 201 – $37 000	19c for each $1 over $18 200
$37 001 – $90 000	$3572 plus 32.5c for each $1 over $37 000
$90 001 – $180 000	$20 797 plus 37c for each $1 over $90 000
$180 001 and over	$54 097 plus 45c for each $1 over $180 000

WORKING	THINKING
a Nil	$18 199 lies in the 0 to $18 200 bracket.
b 19c for each $1 over $18 200	$22 550 lies in the $18 201 to $37 000 bracket.
c $3572 plus 32.5c for each $1 over $37 000	$87 100 lies in the $37 001 to $90 000 bracket.
d $54 097 plus 45c for each $1 over $180 000	$210 500 lies in the $180 001 and over tax bracket.

Example 19 Calculating an employer's superannuation contribution to an employee

Omar has been working part-time and earns $1327.00 per fortnight gross. His employer has been contributing the necessary 9.5% superannuation into his super fund. Calculate the amount per fortnight that Omar's employer is contributing into his super fund.

WORKING	THINKING
$\frac{9.5}{100} = 0.095$	Convert percentage to a decimal by dividing by 100.
$0.095 \times 1327 = \$126.065$ $= \$126.07$	Multiply the decimal by the dollar amount per fortnight.

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Example 20 Identifying information on a PAYG payment summary

Alana's PAYG summary is shown. Note that it says $0 for Reportable Employer Superannuation Contribution. This is for contributions made to the employee's super fund outside of the compulsory 9.5% contribution.

PAYG payment summary – individual non-business
Payment Summary for Year Ending 30 June 2019

Period of payment: Day/Month/Year **01/07/2018** To Day/Month/Year **30/06/2019**

Alana Antonette
5 Citizen Crt
KURANDA 4881 QLD

Payee's tax file number **424359876**

TOTAL TAX WITHHELD $ **23,086**

		Lump sum payments	Type
Gross payments	$ 77,531	A $	
CDEP Payments	$	B $	
Other Payments	$	D $	
Reportable fringe benefits amount	$	E $	
FBT Year 1 April to 31 March Reportable Employer Superannuation Contribution	$ 0		

a Determine whether Alana has provided a TFN to her employer.
b Identify how much tax Alana's employer has withheld from her pay.
c Identify Alana's gross payment amount.
d Calculate her net pay for the year.
e Has Alana's employer made any extra superannuation contributions?
f How much would Alana's employer have contributed in compulsory superannuation?

WORKING	THINKING
a Yes	As per payment summary.
b $23086	As per payment summary.
c $77531	As per payment summary.
d $77531 − $23086 = $54445	Net pay = gross pay − tax withheld
e No extra superannuation contributions have been made.	As per payment summary.
f $0.095 \times \$77531 = \$7365.445$ $= \$7365.45$	$\frac{9.5}{100} = 0.095$ Multiply the decimal by the gross dollar amount.

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Exercise 8E

FUNDAMENTALS

1 Demonstrate your understanding of terms by filling in the missing words in the following statements.

- **a** _____ is a personal investment account for use in retirement.
- **b** Employers must pay a fixed percentage of an _____'s wage into a _____ fund.
- **c** _____ is money that is withheld from your wage and paid to the Australian Taxation Office.
- **d** A _____ _____ _____ (_ _ _) is a personal identification number used in the _____ and _____ financial systems.
- **e** ____ ___ ____ ___ (_ _ _ _) refers to paying tax regularly from your wage and is calculated on your expected _____ income.

2 Calculate 9.5% of each of the following amounts, rounding the answer to the nearest cent.

- **a** $1398.00
- **b** $2468.40
- **c** $4487.80
- **d** $9889.75
- **e** $18711.10
- **f** $27865.35

Hint Convert percentage to a decimal by dividing by 100.

3 Determine whether the following statements are true or false.

- **a** Gross payment is the money you earn before tax is taken out.
- **b** Superannuation is money taken out of your pay for tax purposes.
- **c** Employers must pay superannuation at a compulsory contribution of 9.5%.
- **d** You do not have to have a Tax File Number but you will pay more tax if you don't.
- **e** Net pay is the money you receive after tax has been taken out.
- **f** PAYG stands for 'pay as you go'.
- **g** Taxation is taken out of your earnings so that you can save for your retirement.

Example 18

4 Shown is a tax rate table from the Australian Taxation Office (ATO). If the following amounts represent annual taxable incomes, state how to calculate the tax on this income by identifying the taxable income bracket in which the amount lies.

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Resident tax rates 2018–19

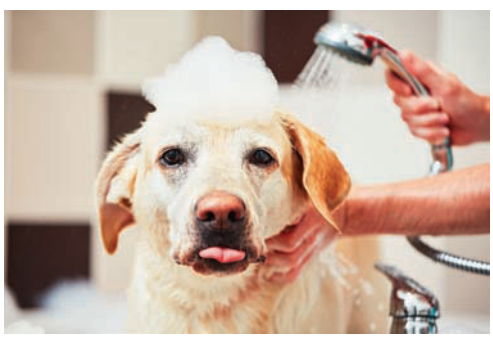
Taxable income	Tax on this income
0–$18 200	Nil
$18 201–$37 000	19c for each $1 over $18 200
$37 001–$90 000	$3572 plus 32.5c for each $1 over $37 000
$90 001–$180 000	$20 797 plus 37c for each $1 over $90 000
$180 001 and over	$54 097 plus 45c for each $1 over $180 000

a $14 578 **b** $33 745 **c** $36 745 **d** $55 374
e $87 112 **f** $95 438 **g** $18 150 **h** $180 011

APPLICATIONS

SF: 5–11 | CF: – | CU: –

★**5** In each of the following scenarios, decide whether the employers of the following individuals should contribute to their superannuation fund. You might wish to refer to the information in the What You Need to Know section to help you.



a Jasper works once a week for a dog grooming company, washing dogs. He earns $490 per month.
b Mick is 21 years old and a part-time bus driver. He earns $2700 per month.
c Lisa is privately employed as a nanny. She works for 27 hours per week and earns a total of $2457 per month.
d Daniel, aged 16 years, works on a casual basis at a fast-food chain for no more than 12 hours per week.
e Jessica works as a part-time nurse and earns $4974 per month.
f Joan is 17 years old and works 38 hours per week as a full-time administration clerk.
g Kyosti, aged 21 years, is a university student and earns $570 per month working at a café.

Example 19 ★**6** Hayden works as a plumber and earns $1326.92 per week. His employer must contribute the compulsory 9.5% superannuation into his super fund account. Calculate the amount Hayden's employer must contribute each week.

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★7 Karen works full-time in a book store. She earns $3543.33 per month. Calculate the amount her employer must contribute into her super fund each month.

★8 Anita is a music teacher, earning $69 375 p.a. Calculate the amount of money her employer would have contributed to her super fund last year.

★9 Michael is 15 years old. Calculate the amount of superannuation his employer must contribute in each of the following circumstances.

- **a** He earns a total of $437 in November.
- **b** He is on school holidays and works for 27 hours per week, earning himself $1782 in the month of December.
- **c** He is on holidays and works for 31 hours per week, earning himself $2045.90 in the month of January.

Example 20 ★10 Refer to Beryl's PAYG summary, shown here, and answer the following questions.

PAYG payment summary – individual non-business
Payment Summary for Year Ending 30 June 2019

Period of payment — Day/Month/Year **01/07/2018** To Day/Month/Year **30/06/2019**

Payee's tax file number **24261275**

TOTAL TAX WITHHELD $ **13,435**

Beryl Mathews
79 Country Drive
Mackay QLD 4740

		Lump sum payments	Type
Gross payments	$ **57,854**	A $	
CDEP Payments	$	B $	
Other Payments	$	D $	
Reportable fringe benefits amount FBT Year 1 April to 31 March	$	E $	
Reportable Employer Superannuation Contribution	$ **0**		

- **a** Decide whether or not Beryl has provided a TFN to her employer.
- **b** Identify how much tax Beryl's employer has withheld from her pay.
- **c** Identify Beryl's gross payment amount.
- **d** Calculate her net pay for the year.
- **e** Determine if Beryl's employer has made any extra superannuation contributions this year.
- **f** Calculate how much her employer would have contributed in compulsory superannuation.

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★11 Refer to Allan's PAYG summary, shown here, and answer the following questions.

PAYG Payment Summary – individual non-business

Payment Summary for year ending 30 June 2019

Period during which payments were made: **1/07/2018** to **30/06/2019**

Allan Roberts
8 Jingellic Street
Cairns QLD 4870

Payee's tax file number: **1215678998**

TOTAL TAX WITHHELD $ **15,300**

		Lump sum payments	
Gross payments	$ **61,264**	A $ **0**	
CDEP payments	$ **0**	B $ **0**	
Reportable fringe benefits amount FBT Year 1/04/18 to 31/03/19	$ **0**	D $ **0**	
Reportable Employer Superannuation Contributions	$ **0**	E $ **0**	
Total Allowances	$ **0**		

a Determine whether Allan has provided a TFN to his employer.
b Explain what the consequence would be for not providing a TFN.
c Identify how much tax Allan's employer has withheld from his pay.
d Identify Allan's gross payment amount.
e Calculate his net pay for the year.
f Determine if Allan's employer has made any extra superannuation contributions this year.
g Calculate how much his employer would have contributed in compulsory superannuation.

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8F Calculating PAYG tax using periodic tax tables COMPLEX

LEARNING GOALS

- Read and interpret periodic tax tables (i.e. weekly, fortnightly or monthly)
- Calculate periodic tax payments (i.e. weekly, fortnightly or monthly)

What are tax tables?

The Australian Taxation Office (ATO) produces a range of tax tables that help an employer calculate the amount of tax that must be withheld from an employee's pay, depending on whether the employee is paid weekly, fortnightly or monthly.

A road construction worker paid a wage of $1756 per fortnight has $280 tax withheld, leaving the worker $1476 per fortnight 'take-home' or net pay.

Note: *Exercise 8F in this section requires that you have access to tax tables. These can be found in section 8F of the Interactive Textbook, or in the Online Teaching Suite.*

WHAT YOU NEED TO KNOW

- **The Australian Taxation Office** (**ATO**) produces **tax tables** that list the tax required to be withheld from an employee's weekly, fortnightly or monthly wage. These tables include wage amounts with the compulsory tax amount to be withheld. They can be downloaded from: https://www.ato.gov.au/rates/tax-tables/
- The **tax-free threshold** is the maximum amount of annual income that does not require taxation. An employee with one job normally claims the tax-free threshold, as it reduces the amount of regular tax withheld. However, it is often not claimed on a second job, so as to avoid a tax bill to pay at the end of a financial year (June 30th).

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Example 21 Identifying information from a weekly tax table

Refer to the tables to determine the amount of tax that must be withheld when an individual is paid $942.00 per week, given that the individual claims the tax-free threshold.

Weekly tax table

	Amount to be withheld			Amount to be withheld	
Weekly earnings 1 $	**With tax-free threshold 2 $**	**No tax-free threshold 3 $**	**Weekly earnings 1 $**	**With tax-free threshold 2 $**	**No tax-free threshold 3 $**
856.00	133.00	254.00	941.00	162.00	283.00
857.00	133.00	254.00	942.00	162.00	284.00
858.00	133.00	255.00	943.00	163.00	284.00
859.00	134.00	255.00	944.00	163.00	284.00
860.00	134.00	255.00	945.00	163.00	285.00

WORKING **THINKING**

$162

In the tax table shown, find $942.00 in the list of weekly earnings. Given that the individual claims the tax-free threshold, use the 'with tax-free threshold column' to read off the value.

Example 22 Calculating fortnightly tax payments using a tax table

Kathryn works two jobs. One is as an accountant's admin assistant, earning $990.00 per fortnight. She does *not* claim the tax-free threshold for this income. Her second job is working as a telemarketer, which pays $476 per fortnight. She claims the tax-free threshold for this income.

Refer to the tables on the next page to calculate Kathryn's:

a fortnightly net income for her job as a telemarketer

b fortnightly net income for her job as an accountant's admin assistant

c total fortnightly net income

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Fortnightly tax table

	Amount to be withheld			Amount to be withheld	
Fortnightly earnings 1 $	With tax-free threshold 2 $	No tax-free threshold 3 $	Fortnightly earnings 1 $	With tax-free threshold 2 $	No tax-free threshold 3 $
302.00	—	66.00	472.00	—	104.00
304.00	—	66.00	474.00	—	106.00
306.00	—	66.00	476.00	—	106.00
308.00	—	66.00	478.00	—	106.00
310.00	—	68.00	480.00	—	106.00
642.00	—	144.00	982.00	68.00	254.00
644.00	—	146.00	984.00	68.00	254.00
646.00	—	146.00	986.00	68.00	256.00
648.00	—	146.00	988.00	68.00	256.00
650.00	—	146.00	990.00	70.00	256.00

WORKING	THINKING
a $476 – $0 = $476 net income per fortnight	Kathryn does claim the tax-free threshold in her job as a telemarketer. Therefore, read off the amount to be withheld in the 'with tax-free threshold' column. There is no tax to be paid.
b $990 – $256 = $734 net income per fortnight	Find $990 in the fortnightly earnings column. Given that Kathryn does *not* claim the tax-free threshold for this income, read off the amount to be withheld in the 'no tax-free threshold' column. The amount is $256 per fortnight.
c $734 + 476 = $1210 total net income per fortnight	Add both fortnightly incomes to calculate the total net income.

Exercise 8F

Note: *Exercise 8F requires that you have access to tax tables. These can be found in section 8F of the Interactive Textbook, or in the Online Teaching Suite.*

FUNDAMENTALS

1 Demonstrate your understanding of terms by filling in the missing words in the following statements.

a The _____ _____ _____ (_ _ _) produces tax tables that list the required tax amounts to be _____ from an employee's wage.

b The _____-____ threshold is the maximum amount of annual income that does ___ require taxation.

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Example 21

2 Refer to the weekly tax table provided in the interactive textbook and determine the amount of tax that must be withheld for each of the following weekly incomes, given that all the individuals claim the tax-free threshold.

a $261.00 **b** $347.00 **c** $468.00
d $516.00 **e** $547.00 **f** $560.00

3 Refer to the fortnightly tax table given in the interactive textbook and find the amount of tax that must be withheld for the following fortnightly incomes, given that all the individuals claim the tax-free threshold.

a $1322.00 **b** $1502.00 **c** $1704.00 **d** $1868.00
e $1910.00 **f** $1516.00 **g** $1494.00 **h** $1206.00

4 Refer to the monthly tax tables given in the interactive textbook and determine the amount of tax that must be withheld for the following monthly incomes, given that all the individuals claim the tax-free threshold.

a $4350.67 **b** $4528.33 **c** $4857.67
d $5447.00 **e** $5828.33 **f** $6001.67

APPLICATIONS

SF: – | CF: 5–11 | CU: 12

★5 Carl has been offered a new position as a tennis coach. His contract states that he will earn a weekly income of $516. This is Carl's only income and so he claims the tax-free threshold.

a Refer to the weekly tax table given in the Interactive Textbook to determine how much tax will be withheld from Carl's pay each week.
b Calculate the amount of money Carl will receive after paying tax.

★6 Krista works part-time as an office manager for a law firm. She is paid $1326 per fortnight. She does not claim the tax-free threshold as she also runs a family day-care service twice a week.

a Refer to the fortnightly tax table given in the Interactive Textbook to determine how much tax will be withheld from Krista's fortnightly pay.
b Calculate the amount of money Krista will receive fortnightly from this job after paying tax.

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★7 Indianna is a real estate agent who is paid a retainer on a monthly basis. Her retainer is $3614.00 per month and she does not claim the tax-free threshold on this amount as she also earns commission and fears that she will have a tax bill at the end of the financial year. She would rather pay extra tax to be sure that she does not end up with a tax bill later.

a Refer to the monthly tax table given in the interactive textbook to find how much tax is withheld per month from Indianna's retainer.

b Calculate the amount of money Indianna will receive in her monthly retainer after paying tax.

★8 Joel works at a recycling depot. He is paid $1542.00 per fortnight and he claims the tax-free threshold. Using the tax table given in Question **2**, calculate Joel's fortnightly pay.

★9 Katrina works in a boutique clothing store and earns $3618.33 per month. This is her only income so she claims the tax-free threshold. Using the tax table given in the Interactive Textbook, calculate Katrina's monthly pay.

Example 22 ★10 Casey has two part-time jobs. Her first job, working in customer service, pays her a gross income of $560 per week and she does not claim the tax-free threshold for this amount. However, Casey does claim the tax-free threshold for her second job as a childcare worker, which pays her a gross weekly income of $474 per week. Calculate the amount of money Casey gets paid each week after tax has been withheld.

★11 Ashleigh works for two organisations as a disability support worker. His first job pays him $3635.67 per month and his second job pays him $3237.00 per month. He does not claim the tax-free threshold on either of his incomes. Using the tax table given in the interactive textbook, calculate Ashleigh's monthly net income.

★12 River installs sheds for a living. His contract states that he will earn $51 896.04 p.a. Using the tax tables given in the interactive textbook, calculate the amount of pay he will receive into his bank account if his pay period is:

a weekly **b** fortnightly **c** monthly

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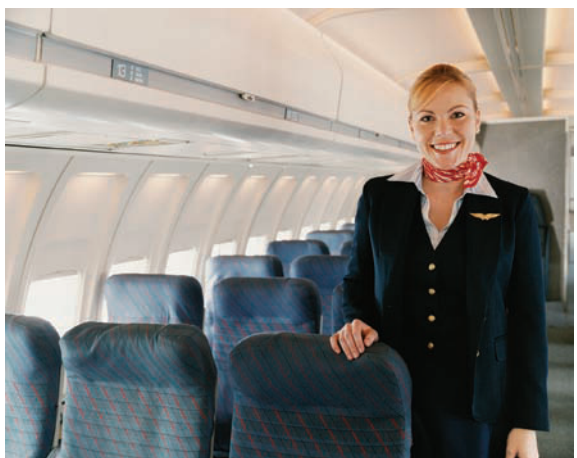
8G Apply tax deductions to calculate taxable income

LEARNING GOALS

- Calculate taxable income when given gross income and deductions
- Calculate total tax deductions and taxable income
- Apply tax deduction allowances when calculating taxable income

When do tax deductions apply?

For some jobs, there are certain costs that a person may have been required to pay in order to complete their work. So when they complete their tax return at the end of the financial year, these costs can be deducted from the person's gross income to calculate their taxable income. This essentially reduces the amount of tax the person is required to pay.



A flight attendant can claim tax deductions for work-related expenses such as dry cleaning, car hire, meals and overnight accommodation.

WHAT YOU NEED TO KNOW

- **Gross** income is the amount of income received before tax has been deducted.
- **Net** income is the amount received after tax has been deducted. Gross income and net income can be calculated per pay period or per annum.

$$\text{Net income} = \text{gross income} - \text{tax withheld or paid}$$

- **Tax deductions** include any allowed work-related expenses, such as protective clothing, washing of uniforms, computer, travel and training courses. The total of work-related expenses is subtracted from the gross income, to calculate the taxable income.
- **Taxable income** is the amount of income that is used to calculate the annual tax payable. It is calculated only after June 30, the end of the financial year.

$$\text{Taxable income} = \text{gross income} - \text{tax deductions}$$

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- There are two systems for claiming a tax deduction for car expenses.
  - **Cents per kilometre** This system allows an individual to multiply the ATO supplied rate of 66 cents/km by the total of work-related kilometres driven in the financial year.
    For example: 1570 km at 66 cents/km gives a deduction of $1570 \times 0.66 = \$1036.20$.
  - **Logbook method** This system is based on the percentage of business use-related vehicle expenses, such as the running costs (e.g. fuel, oil, maintenance) and the decline in the vehicle's value.
    For example: If 30% of a vehicle's use has been to conduct a business (e.g. a florist), then the person can claim 30% of the running costs as a deduction.

Example 23 Calculating taxable income given gross income and tax deductions

Liana earnt a gross amount of $46 350 in the past financial year, working as a hairdresser. Her tax has been paid using the PAYG system. Liana has calculated that she has spent a total of $1357.80 on work-related expenses that can be classed as tax deductions. Calculate Liana's taxable income.

WORKING	THINKING
$\$46\,350 - \$1357.80 = \$44\,992.20$	Gross income − Tax deductions = Taxable income

Example 24 Calculating total tax deductions and taxable income

Phil works full-time as a concreter and earns $69 730.20 p.a. His tax deductions include: $380 for tools, $25 for sunscreen, $40 for a sunhat, $160 for two pairs of safety work boots, $140 for two pairs of overalls with the business' logo, $73.60 in washing costs and $90 to complete a Workplace Safety training course.

a Calculate Phil's total deductions.

b Calculate his taxable income.

WORKING	THINKING
a $908.60	Add all of Phil's deductions.
b $\$69\,730.20 - \$908.60 = \$68\,821.60$	Gross income − Tax deductions = Taxable income

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Example 25 Applying tax deduction allowances and calculating taxable income

Ellie works for a mobile pet grooming company, earning $38 750 p.a. Her tax deductions include: $140 for equipment, $110 for sun protection, $30 for gumboots, $95 for uniform with the company's logo, $8 per week for dry cleaning her work clothes, and she uses 20% of her mobile phone on work-related phone calls and messages, for which she pays $79 per month.
Ellie has also recorded the number of kilometres she has travelled using her own car, which added to 4950 km.
Calculate the following.

a Ellie's deductions for dry cleaning, phone and car expenses
b Her total tax deductions
c Ellie' taxable income

WORKING	THINKING
a Dry cleaning expenses: $= \$8 \times 52 = \$416$ per year	Yearly dry cleaning expense = cost per week × 52
Phone expenses: $= 0.2 \times 79 \times 12$ $= \$189.60$ per year	Phone cost per month $= 20\% \times 79 = 0.2 \times 79$ Yearly phone expense = cost per month × 12
Car expenses: $= 4950 \text{ km} \times 0.66$ $= \$3267$	Allowed car travel claim is 66 cents/km. Yearly car expense = 0.66 × number of km
b Total tax deductions $= \$4247.60$	Add all tax deductions.
c Taxable income $= \$38\,750 - \$4247.60$ $= \$34\,502.40$	Gross income − Tax deductions = Taxable income

Exercise 8G

FUNDAMENTALS

1 Demonstrate your understanding of terms by filling in the missing words in the following statements.

a _____ income = _____ income – tax
b Tax _____ include any work-related expenses.
c _____ income = gross income – _____

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2 Calculate the amount of money that can be claimed as a tax deduction for each of the following kilometres, at the rate of 66 cents per kilometre.

a 355 km **b** 1234 km **c** 2455 km
d 3149 km **e** 4890 km

3 The percentage that can be claimed for each of the following deductions is given. Calculate the amount of money that can be claimed per annum as a tax deduction.

a 10% of $60 per month **b** 15% of $110 per month
c 5% of $15 per week **d** 20% of $20 per week

Example 23

4 Saxon earnt a gross amount of $62 350 in the past financial year, working as a painter. He has calculated that he spent a total of $3587.40 on work-related expenses. Calculate Saxon's taxable income.

Hint: Taxable income = gross income − tax deductions

5 Kiara earned a gross income of $41 576 working at a childcare centre. She has calculated that she spent a total of $390 on work-related expenses. Calculate Kiara's taxable income.

APPLICATIONS

SF: – | CF: 6–10 | CU: 11

Example 24

★6 Blake works as a pest exterminator, earning $47 899 p.a. His tax deductions include $180.00 for protective clothing; protective items, such as goggles, to a total of $165; weekly dry cleaning at $8 per week; and equipment at the cost of $549.70. Calculate Blake's taxable income.

★7 Jackson works as a pool installer, earning $58 137.60 p.a. His tax deductions include: $160 for having the previous year's tax return prepared by an accountant; $170 in charity donations; $140 for protective clothing; $25 for sunscreen; $40 for a sunhat; $80 for boots; and he uses his phone, for which he pays $99 per month, for work-related phone calls 15% of the time. Calculate Jackson's total tax deductions.

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Example 25 ★8 Connie is a carpenter earning $71 800 p.a. Her tax deductions include: $140 for protective clothing; $19 for sunscreen; $1870 on tools; $150 for having her previous year's tax return prepared by an accountant; $672 sponsoring a child through a charity organisation; $80 for boots; $7.50 on weekly dry cleaning; and she uses her phone, for which she pays $69 per month, for work-related phone calls 25% of the time. Calculate Connie's total tax deductions.

★9 Sam works as a personal assistant, earning $53 599 p.a. His tax deductions include $180.00 on the required uniform with the company's logo, stationery for $37 and charity donations of $108. Occasionally, Sam is required to use his car to pick up or deliver work items. He keeps a record of the kilometres travelled and this year he has travelled 1230 km. Calculate Sam's taxable income.

★10 Lynsey works in a gym as a trainer, earning $51 700 p.a. Her tax deductions include $210 for shoes, $180 for a Zumba training course, $80 for uniform and $50 for charity donations. Lynsey also conducts personal training sessions, for which she uses her phone and her own car. Her phone plan costs $15 per week and she uses 30% of this for work-related phone calls. She has travelled 3795 km this year travelling between clients. Calculate her taxable income.

★11 Leonie works from home as an accounts manager. She earns $1150.50 per fortnight.

a Calculate Leonie's annual gross income.

b Leonie has a room in her house set up as an office for her job. This room takes up 10% of the total area of her house. Leonie's total household expenses are $13 750 p.a. Calculate how much she can claim as a tax deduction for this.

c Leonie has other tax deductions that include 60 km of work-related car expenses per week, stationery costs at $194 for the year, and she has receipts to show she has donated $780 to registered charities this year. Calculate Leonie's taxable income for the year.

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8H Medicare levy COMPLEX

LEARNING GOALS

- Calculate the Medicare levy on a given taxable income
- Calculate the Medicare levy surcharge on a given taxable income
- Calculate the Medicare levy for a person without private health insurance

What is Medicare?

Medicare is a service provided by the Australian Government that allows all Australian residents to have access to health care. It is partly funded by all taxpayers, who pay a levy on their taxable income.

The Medicare levy pays part or all the costs of medical services such as CT scans, X-rays, general practitioner and optometrist visits, hospital stays and many prescriptions.

WHAT YOU NEED TO KNOW

- The standard **Medicare levy** is generally charged at 2% of taxable income. It is a tax that partly funds Australian hospital and medical services. If your taxable income is low, you may pay a reduced Medicare levy or no Medicare levy at all.

  Taxable income = gross income − allowed deductions
  Medicare levy = 2% of taxable income

- The **Medicare levy surcharge** (**MLS**) is an extra amount that is paid in addition to the Medicare levy amount. It is paid by anyone who does not have private health insurance and earns over $90 000 p.a. The following table is used to determine the Medicare levy surcharge rate, which is added to the 2%.

Medicare levy surcharge		
	Threshold	**Tier 1**
Singles	$90 000 or less	$90 001–$105 000
Families	$180 000 or less	$180 001–$210 000
Rates	0.0%	1.0%

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- For example: Consider a person who does *not* have private health insurance, is single and earns a taxable income of $100 000.
  Medicare levy surcharge rate = 1% (see table)
  Standard Medicare levy rate = 2%
  Medicare levy rate = 1% + 2% = 3%
  Total Medicare levy payable = 0.03 × $100 000 = $3000

Example 26 Calculating the Medicare levy on a taxable income

Josie works as a dog trainer, earning an annual taxable income of $34 576. Calculate the amount of Medicare levy she pays.

WORKING	THINKING
Medicare levy	Remember: $2\% = \frac{2}{100} = 0.02$
$34 576 × 0.02 = $691.52	Multiply the yearly income by the percentage decimal.
Josie must pay $691.52.	

Example 27 Calculating the Medicare levy for a person without private health insurance

Hendrick is single and his taxable income last year was $92 500. He did not have private health insurance.
The following table applies to people without health insurance. It shows various income thresholds and the rates for the Medicare levy surcharge that apply.

Income thresholds for Medicare levy surcharge rates				
	Threshold	**Tier 1**	**Tier 2**	**Tier 3**
Singles	$90 000 or less	$90 001–$105 000	$105 001–$140 000	$140 001 or more
Families	$180 000 or less	$180 001–$210 000	$210 001–$280 000	$280 001 or more
Rates	0.0%	1.0%	1.25%	1.5%

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a Calculate the amount in dollars for the standard 2% Medicare levy that Hendrick must pay.
b By applying the rate given in the table, calculate the Medicare levy surcharge Hendrick must pay.
c What is the total Medicare levy amount that Hendrick must pay?

WORKING	THINKING
a Medicare levy $= \$92\,500 \times 0.02$ $= \$1850$	$2\% = \frac{2}{100} = 0.02$ Find 2% of the taxable income.
b Medicare levy surcharge $= \$92\,500 \times 0.01$ $= \$925$	The income thresholds table places Hendrick in the singles row, tier 1 column. Hence, his Medicare levy surcharge is 1%.
c Total Medicare levy amount $= \$1850 + \$925$ $= \$2775$	Add together the Medicare levy plus the Medicare levy surcharge.

Exercise 8H

FUNDAMENTALS

1 Demonstrate your understanding of terms by filling in the missing words in the following statements.
a The _____ levy is __% of the taxable income.
b Taxable income = _____ income – _____
c A person without private health insurance who earns more than $90 000 is charged the _____ levy _____.
d The Medicare levy surcharge rate is determined from an income _____ table that is provided by the Australian Taxation Office.
e To calculate the total Medicare levy amount to be paid by a person without private health insurance:
Total _____ levy = _____ _____ at 2% + _____ _____ _____ at a specified surcharge rate.

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Example 26

2 Calculate the normal 2% Medicare levy on the following incomes.

a $38 750 **b** $44 560
c $51 200 **d** $65 600
e $80 500 **f** $101 900
g $138 060 **h** $257 000

3 Use the given Medicare levy surcharge table to identify the percentage rate of the Medicare levy surcharge on each of the following amounts. In each case, the person does not have health insurance and is single. Do not calculate the surcharge amount to be paid.

Hint State the Medicare levy surcharge rate only.

Income thresholds for Medicare levy surcharge rates				
	Threshold	**Tier 1**	**Tier 2**	**Tier 3**
Singles	$90 000 or less	$90 001–$105 000	$105 001–$140 000	$140 001 or more
Families	$180 000 or less	$180 001–$210 000	$210 001–$280 000	$280 001 or more
Rates	0.0%	1.0%	1.25%	1.5%

a $76 500 p.a. **b** $102 500 p.a. **c** $128 400 p.a.
d $150 678 p.a. **e** $135 812 p.a. **f** $98 430 p.a.

4 Answer the following questions for each of these combined family incomes.
Green family: $185 000 Wu family: $192 000 Johnston family: $218 642
Russo family: $259 437 Nguyen family: $339 200 Kumar family: $585 637

a Calculate the Medicare levy, assuming the family has private health insurance.
b Calculate the Medicare levy, assuming the family does not have private health insurance.
c For each family, calculate the difference in Medicare levies paid with private health insurance and without private health insurance.

APPLICATIONS

SF: – | CF: 5–11 | CU: 12, 13

Example 27

★**5** Andrew is single and has calculated that he earned a total taxable income of $76 500 in the past financial year. He did not have private health insurance. Calculate the Medicare levy Andrew must pay.

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★6 Ronslee is single and has private health insurance. Her taxable income last financial year was $97 580. Calculate the Medicare levy Ronslee must pay.

★7 Troy is single and does not have private health insurance. His total taxable income last year was $106 780. Calculate the Medicare levy he must pay.

★8 Reicka is single and does not have private health insurance. Her total taxable income last financial year was $143 600. Calculate the Medicare levy she must pay.

★9 Tobias and his wife Julie have private health care. Calculate the total Medicare levy to be paid if their combined family taxable income last financial year was $168 500.

★10 Alessio and Davina don't have private health insurance. Last financial year their combined family taxable income was $190 600. Calculate the Medicare levy they must pay.

★11 Jo's taxable income for the past financial year was $1468 per week and she did not have private health insurance.

a Calculate Jo's yearly taxable income.

b Calculate the Medicare levy Jo must pay.

★12 Goran's taxable income is $7725 per month and he does not have private health insurance. Calculate the Medicare levy to be paid on his income.

★13 Anushka's taxable income is $2475.80 per fortnight and she has private health insurance. Calculate the Medicare levy Anushka must pay on her income.

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8I Calculating simple tax returns COMPLEX

LEARNING GOALS

- Calculate income tax payable using an annual tax rates table
- Calculate simple tax returns based on gross and net income, tax deductions and levies

What is a tax return?

At the end of a financial year, anyone who has earned an income must submit a tax return to the Australian Taxation Office. If employed by a workplace, they will provide a payment summary that shows the amount of income and the amount of tax paid through PAYG.

Police officers can reduce their taxable income with allowable deductions such as expenses for their car, tools, equipment, uniform dry cleaning and self-education.

WHAT YOU NEED TO KNOW

- A **financial year** is from July 1 of one year to June 30 of the next year. After June 30 employers must provide a payment summary to each employee, who then completes and submits their tax return to the Australian Taxation Office (ATO).
- The **PAYG payment summary** shows an employee's income and the amount of tax withheld. PAYG stands for the 'pay as you go' tax system for employees.
- **Tax returns** can be completed by the employee or through an accountant. Tax returns declare all income, the tax paid (i.e. PAYG tax), any deductions, and calculations for the taxable income. When a return is done online using the ATO website, the system will estimate whether you owe tax or will receive a refund, but that will be confirmed by the ATO later. The ATO checks that the deductions are valid and that the calculations are correct. The ATO can ask for receipts to justify deductions that have been claimed.

$$\text{Taxable income} = \text{gross income} - \text{tax deductions}$$

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- The **income tax payable** is the amount of tax an individual must pay on their taxable income. The taxpayer will receive a refund if they have paid too much tax during the year (i.e. PAYG tax) or, if they have not paid enough tax, they must pay the difference.

  Tax refund or tax bill = PAYG tax − tax payable shown in tax return

- **Tax rates** are in cents per dollar of income. As incomes increase, tax rates also increase but in steps called 'income brackets'. The ATO publishes various tax rate tables, showing the income brackets and the tax rates in cents/$. The table here applies to an Australian resident.
  - For example: Tax to be paid on $\$47\,000 = \$3572 + (\$0.325 \times \$10\,000)$
    $= \$3572 + \$3250$
    $= \$6822$

Resident tax rates 2018–19

Taxable income	Tax on this income
0–$18 200	Nil
$18 201–$37 000	19c for each $1 over $18 200
$37 001–$90 000	$3572 plus 32.5c for each $1 over $37 000
$90 001–$180 000	$20 797 plus 37c for each $1 over $90 000
$180 001 and over	$54 097 plus 45c for each $1 over $180 000

- The **total tax refund or debt** on an income tax return can be calculated.

1. **Total tax deductions:** Add all the permissible deductions.
2. **Taxable income** = gross income – tax deductions
3. **Income tax payable**
   - **Wage above the tax threshold** in the tax rates table.
     For example, $97 000 is $7000 above the $90 000 threshold.
   - **Apply the given tax table instructions**
     For example: Tax payable on $\$97\,000 = \$20\,797 + (0.37 \times 7000)$
     $= \$23\,387$
4. **Medicare levy** = 2% of your taxable income. Refer to the Medicare levy surcharge table for the additional rate that you must pay if you don't have private health insurance.
5. **Total income tax payable** = income tax payable + Medicare levy
6. **Tax refund or tax debt** = PAYG tax – total tax payable

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Example 28 Calculating income tax payable using the tax rates table

Amal has calculated that her taxable income is $41 900. Use the tax rates table shown to answer the following.

a Identify the tax bracket in which Amal's income falls.

b By how much is Amal's wage above the previous tax bracket (or threshold)?

c Calculate the amount of tax Amal must pay on her taxable income.

Resident tax rates 2018–19

Taxable income	Tax on this income
0–$18 200	Nil
$18 201–$37 000	19c for each $1 over $18 200
$37 001–$90 000	$3572 plus 32.5c for each $1 over $37 000
$90 001–$180 000	$20 797 plus 37c for each $1 over $90 000
$180 001 and over	$54 097 plus 45c for each $1 over $180 000

WORKING	THINKING
a Amal's income falls within the tax bracket $41 900–$90 000.	Amal's taxable income is $41 900, which is in the tax bracket $37 001–$90 000.
b Amal's wage above the previous tax threshold is $41 900 − $37 000 = $4900.	Need to find the difference between Amal's taxable income of $41 900 and the threshold value $37 000.
c Income tax payable = $3572 + ($4900 × 0.325) = $3572 + $1592.50 = $5164.50	Tax is $3572 + 32.5 cents for every $1 over $37 000. So Amal must pay $0.325 of $4900 plus the $3572.

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Example 29 Calculating taxable income and the total tax payable

Jarred is single and earned a gross yearly income of $54574 in the past financial year. He is claiming deductions of $675 for tools, $180 for a training course, $175 for protective clothing and $87 in donations to registered charities. He does not have private health insurance and pays the standard 2% Medicare levy. Use the tax rates table in **Example 28** and the following table to calculate Jarred's:

a total tax deductions
b taxable income
c wage above the tax threshold
d income tax payable
e Medicare levy
f total tax payable for the year

Income thresholds for Medicare levy surcharge rates				
	Threshold	**Tier 1**	**Tier 2**	**Tier 3**
Singles	$90000 or less	$90001–$105000	$105001–$140000	$140001 or more
Families	$180000 or less	$180001–$210000	$210001–$280000	$280001 or more
Rates	0.0%	1.0%	1.25%	1.5%

WORKING

a Total tax deductions
$= \$675 + \$180 + \$175 + \$87$
$= \$1117$

b Taxable income
$= \$54574 - \$1117$
$= \$53457$

c Wage above the tax threshold
$= \$53457 - \$37000$
$= \$16457$

d Income tax payable
$\$3572 + (\$16457 \times 0.325)$
$= \$3572 + \$5348.525$
$= \$8920.53$

e Medicare levy
$\$53457 \times 0.02 = \$1069.14$

f Total tax payable
$\$8920.53 + \$1069.14 = \$9989.67$

THINKING

Add the tax deductions.

Taxable income
= gross income – tax deductions

Jarred's taxable income falls between $37001 and $90000. Calculate the difference between $53457 and $37000.

Calculate $3572 + 32.5 cents for every $1 over $37000. Write 32.5 cents as $0.325.

Jarred must pay the 2% Medicare levy on his taxable income.

$$2\% = \frac{2}{100} = 0.02$$

He does not have to pay the Medicare levy surcharge because his taxable income is less than $90000.

Total tax payable = income tax payable + Medicare levy

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Example 30 Calculating a tax return

An extract from Natalie's payment summary is shown. She does not have private health insurance and her taxable deductions totalled $1260.

a Calculate Natalie's taxable income.
b Calculate her income tax payable.
c Determine the Medicare levy she must pay.
d Calculate the amount that Natalie should receive as a tax refund or the amount of her tax debt.

Payee's tax file number **4242612756**		**TOTAL TAX WITHHELD $**	**23,086**	
		Lump sum payments		Type
Gross payments	$ **89,531**	A $		

WORKING	THINKING
a Taxable income = $89531 – $1260 = $88271	Taxable income = gross income – deductions
b Wage above the tax threshold = $88271 − $37000 = $51271	Wage above the tax threshold is the difference between $88271 and $37000, which is $51271.
Income tax payable = $3572 + ($51271 × 0.325) = $3572 + $16663.08 = $20235.08	Income tax payable is $3572 + 32.5 cents for every dollar of $51271. Write 32.5 cents as a rate of $0.325. $51271 × 0.325 = $16663.075 After rounding up to two decimal places, this equals $16663.08.
c Medicare levy $88271 × 0.02 = $1765.42	Natalie must pay 2% Medicare levy. $2\% = \frac{2}{100} = 0.02$
d Total income tax payable = $20235.08 + $1765.42 = $22000.50	Total income tax payable = income tax payable + Medicare levy
Tax refund = $23086 – $22000.50 = $1085.50	Total tax withheld is the PAYG tax. Calculate PAYG tax – total tax payable. PAYG tax is greater than total tax payable, so a refund is due to Natalie.

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Exercise 8I

FUNDAMENTALS

1 Demonstrate your understanding of terms by filling in the missing words in the following statements.

- **a** A _____ summary shows a person's _____ and the amount of _____ withheld.
- **b** PAYG stands for the _____ _____ _____ _____ tax system for employees.
- **c** Taxable _____ = _____ income – _____
- **d** Tax refund = (_ _ _ _ tax) – (tax payable calculated in the _____ _____).
- **e** ATO stands for _____ _____ _____.
- **f** If a person has _____ paid enough tax, they must pay the ATO the _____.
- **g** The ATO tax rate table shows the various _____ brackets and the tax _____ in _____ per $.

2 Calculate the taxable income for the following individuals.

- **a** Riley earned $49 504 last financial year and his tax deductions total $1118.60.
- **b** Sandra earned $94 405 last financial year and her tax deductions total $2890.
- **c** Michael earned $78 300 last financial year and his tax deductions included: $170 to registered charities, $990 for tools, $125 for uniforms, $8.70 per month for dry cleaning and $270 for car expenses.

3 Australians who earn over a certain amount pay 2% Medicare levy. Individuals and families who earn more than a certain amount and do not have health insurance, must pay a Medicare levy surcharge as well as the 2% Medicare levy. The surcharge rates are given in the following table.

Income thresholds for Medicare levy surcharge rates

	Threshold	Tier 1	Tier 2	Tier 3
Singles	$90 000 or less	$90 001–$105 000	$105 001–$140 000	$140 001 or more
Families	$180 000 or less	$180 001–$210 000	$210 001–$280 000	$280 001 or more
Rates	0.0%	1.0%	1.25%	1.5%

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Use this information to calculate the total Medicare levy the following individuals must pay to the ATO.

a Vicky is single, earns $78 500 p.a. and has private health insurance.

b Mick is single, earns $115 000 p.a. and does not have private health insurance.

c Jacqueline and Rob earn a combined income of $109 450 p.a. and they do have private health insurance.

d Ralph is single, earns $217 900 p.a. and does not have private health insurance.

Example 28a, b

4 For each of the annual incomes listed below, use the tax rates table to identify the tax bracket in which the income falls and therefore which income tax calculation (from the second column) is to be used. Do not calculate the amount of tax to be paid.

Resident tax rates 2018–19

Taxable income	Tax on this income
0–$18 200	Nil
$18 201–$37 000	19c for each $1 over $18 200
$37 001–$90 000	$3572 plus 32.5c for each $1 over $37 000
$90 001–$180 000	$20 797 plus 37c for each $1 over $90 000
$180 001 and over	$54 097 plus 45c for each $1 over $180 000

a $16 250 p.a. **b** $21 390 p.a. **c** $36 100 p.a.

d $43 295 p.a. **e** $96 450 p.a.

APPLICATIONS

SF: – | CF: 5–10 | CU: 11

★5 Grace works long hours as a pastry chef and earns $89 580 p.a. Using the tax rates table presented in Question **4**, calculate the amount of tax payable on her income.

Example 28c

★6 Asher works as a Transportation Inspector and last financial year he earns a gross income of $68 900. Using the tax rates table presented in Question **4**, calculate the amount of tax payable on Asher's income.

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Example 29 ★7 Lucas is a commercial diver, earning $59 550 p.a. in the past financial year. He is claiming deductions that include: tools $195, scuba tank $649, sunscreen $25 and $370 in donations to registered charities. He has private health insurance and pays the 2% Medicare levy. Using the tables presented in Questions **3** and **4**, calculate his income tax payable, including the Medicare levy amount he must pay.

★8 Freya is a personal assistant to a school principal and earns $58 670 p.a. Her tax deductions include $35 for stationery, $110 for work uniforms with the school logo and $75 in donations to registered charities. Every week she travels to the local post office in her own vehicle, which is a return trip of 28 km for which she claims 66 cents per kilometre. Freya does not have private health insurance. Calculate her income tax payable, including the Medicare levy.

Example 30 ★9 Merisa's payment summary is shown. She has private health insurance and her taxable deductions totalled $576.

PAYG payment summary – individual non-business
Payment Summary for Year Ending 30 June 2019

Period of payment: Day/Month/Year **01/07/2018** To Day/Month/Year **30/06/2019**

Merisa Jones
73 Tamare Crt
Gold Coast QLD 4207

Payee's tax file number **242612756**

TOTAL TAX WITHHELD $ **13,435**

			Lump sum payments	Type
Gross payments	$ 57,854	A	$	
CDEP Payments	$	B	$	
Other Payments	$	D	$	
Reportable fringe benefits amount FBT Year 1 April to 31 March	$	E	$	
Reportable Employer Superannuation Contribution	$ 0			

a Calculate Merisa's taxable income.
b Calculate the amount of tax that is payable on her income.
c Calculate the Medicare levy amount she must pay.
d Calculate the amount that Merisa should receive as a tax refund or the amount of her tax debt.

★10 Liam's payment summary is given. He was paid $43 799 p.a. plus paid allowances of $2516, on which he does not pay tax. He does not have private health insurance and his total deductions totalled $790. Calculate the amount that Liam should receive as a tax refund or the amount of his tax debt.

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PAYG payment summary – individual non-business

Payment summary for year ending 30 June 2019

Period during which payments were made — Day/Month/Year **1-Jul-2018** to Day/Month/Year **30-Jun-2019**

Liam West
7 Taylors Street
Weipa QLD 4874

Payee's tax file number **3415212543**

TOTAL TAX WITHHELD $ 14,068

		Type		Lump sum payments	Type
Gross payments	$ 43,799	S	A $	0	
CDEP payments	$ 0		B $	0	
Reportable employer superannuation contributions	$ 0		D $	0	
Reportable fringe benefit amount FBT Year 1 April to 31 March	$ 0		E $	0	

Is the employer exempt from FBT under section 57A of the FBTAA 1986? No ☐ Yes ☐

Total Allowances $ 2,516 — Total allowances are not included in Gross payments above. This amount needs to be shown separately in your tax return.

Exempt foreign employment income $ 0

Allowances:
Kilometres To 5000KM $2,171
Phone Allowance $345

★**11** Joshua's payment summary is shown. He does not have private health insurance and his tax deductions totalled $1874. Calculate the amount that Joshua should receive as a tax refund or the amount of his tax debt.

PAYG payment summary – individual non-business

Payment Summary for Year Ending 30 June 2019

Period of payment — Day/Month/Year **01/07/2018** To Day/Month/Year **30/06/2019**

Joshua Seymour
98 Fennel Street
Birdsville QLD 4482

Payee's tax file number **2426689**

TOTAL TAX WITHHELD $ 25,080

			Lump sum payments	Type
Gross payments	$ 99,986	A	$	
CDEP Payments	$	B	$	
Other Payments	$	D	$	
Reportable fringe benefits amount FBT Year 1 April to 31 March	$	E	$	
Reportable Employer Superannuation Contribution	$ 0			

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★12 Below is an image of Elizabeth's group certificate. She does not have private health insurance and her tax deductions included the following.

- stationery and tools $130
- sunscreen $25
- sunhat $40
- sunglasses $120
- uniform $180
- dry cleaning $12.90 per month
- travel expenses 1872 km at 66 cents per km
- personal phone, for which she pays $89 per month and uses 25% of the time for work.

Calculate the amount that Elizabeth should receive as a tax refund or the amount of her tax debt.

PAYG payment summary – individual non-business
Payment Summary for Year Ending 30 June 2019

Period of payment: Day/Month/Year **01/07/2018** To Day/Month/Year **30/06/2019**

Elizabeth Townsend
1 Ocean Street
Brisbane QLD 4000

Payee's tax file number **54567876**

TOTAL TAX WITHHELD $ **23,086**

		Lump sum payments	Type
Gross payments	$ 77,531	A $	
CDEP Payments	$	B $	
Other Payments	$	D $	
Reportable fringe benefits amount FBT Year 1 April to 31 March	$	E $	
Reportable Employer Superannuation Contribution	$ 0		

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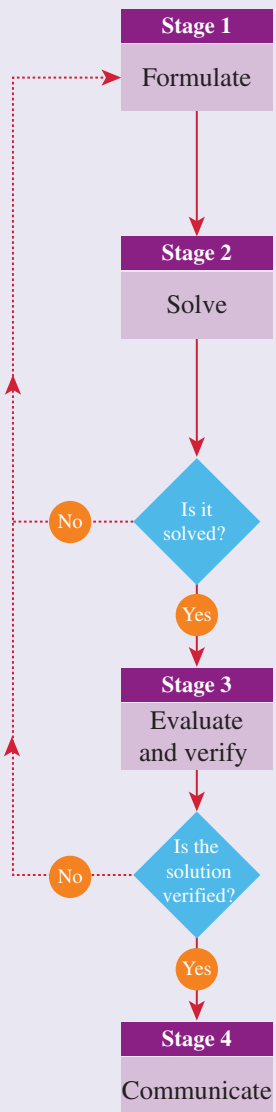
Problem-solving and modelling task

Background: Different careers can vary considerably in required education and experience, employment rates, average income, and the kinds of tax deductions possible. Wise career choices start from knowing such aspects of the career options.

CAREERS

Task: Your task is to research two careers of your choice. You must compare and contrast these two careers and conclude which career is the best option for you.

To complete this task, follow the problem-solving workflow diagram below and use the steps listed as a guide.



Stage 1: Formulate

1 Decide on two career options that are of interest to you.
2 Describe what you think is involved in each career.

Stage 2: Solve

3 Research what each position involves in both careers.
4 Research what the employment rate is like for each career.
5 Determine what experience and/or education is required for each career.
6 Research the average income of each career.
7 Research the types of tax deductions that apply to both careers.

Stage 3: Evaluate and verify

8 Check that you have gathered the required information on the two careers, that you have enough to make a comparison between them, and that you have reached a conclusion that you can justify.

Stage 4: Communicate

9 Communicate your findings in a short report that reflects on both careers and conclude which career best suits you.

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Puzzle

WHAT IS THE LEAST STRESSFUL JOB IN THE WORLD?

A study was conducted in 2017 to determine the most stressful job in the world and the least stressful job in the world. The number one most stressful job was identified as enlisted military personnel.

The job that was identified as being the least stressful can be found by solving the puzzle.

Solve the following questions and use each answer to fill in the question letter above the answer in the grids below.

1 For these time periods, calculate the number of hours in decimal time.

A 8:30 a.m. to 1 p.m.

C 6 a.m. to 2:30 p.m.

D 12 p.m. to 9:15 p.m.

E 11:30 p.m. to 4:15 p.m.

2 Calculate the total income earned for the following individuals.

G Sal earns $12.48 per hour and worked for 6 hours.

H Allen earns $25.70 per hour and worked for 8 hours.

I Lyn earns $19.70 per hour and worked on Saturday at time and a half for 6 hours.

L Graham earns $16.85 per hour and worked on Australia Day at double time for 8 hours.

M Rodney earns $18 for every car he details and completed seven cars in one day.

N Dianne earns 3% commission for each car she sells and she sold a car for $45 999.

O Neil earns 8% commission on sales, selling $11 200 worth of goods.

3 Complete these superannuation calculations.

P $1200 × 9.5% = ____

R $2300 × 9.5% = ____

S $4570 × 9.5% = ____

$126	4.75	9.25	$177.30	8.5	4.5	$269.60

$434.15	$896	$1379.97	$896	$74.88	$218.50	4.5	$114	$205.60	4.75	$218.50

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Chapter checklist

☐ I calculate salary, wages, overtime, piecework and commission.

1. Describe the difference between a salary and a wage.
2. Ashley earns $21.70 per hour. Calculate his income if he works for 8 hours and then works overtime by 2 hours at a rate of time and a half.
3. Justine is paid $2.10 per cupcake that she bakes. Calculate her income if she makes 48 cupcakes.
4. Ella earns 5% commission on all sales. If she sells $18 000 worth of goods, calculate her earnings.

☐ I understand the purpose of superannuation, taxation and the use of a TFN.

5. What is the compulsory rate of superannuation that an employer must pay?
6. Discuss the need for taxation.
7. Explain the consequence if an individual does not have a Tax File Number.

☐ I can interpret entries on payslips, timesheets and PAYG summaries.

8. Discuss the purpose for each of the following.
   a. payslip
   b. timesheet
   c. PAYG summary

Name: Riley Berger — Health4Life

Address: 9 Second Street, Maleny 4560 — ABN: 19886537270879

Pay Period from 6/5/19 to 13/5/19 — Employee ID: 1f45

Pay Type: Casual Ord

Hours: 33	**Hourly Rate:** $27.50	**Amount:** $907.50

Gross: $907.50 — YTD Gross: $29,347.50

Tax: $155.00 — YTD Tax: $3,948.00

Net: $752.50 — YTD Net: $25,399.50

Annual Sick Leave: 0 hours

Superannuation: Sky Super — **Amount:** $86.51

Banking details: OZBank a/c 345980 — **Amount:** $752.50

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9 Refer to Riley's payslip to answer the following questions.
- **a** How much does Riley earn per hour?
- **b** How many hours did he work in the pay period shown?
- **c** What is Riley's gross income?
- **d** How much tax did he pay?
- **e** How much money was paid into his bank account?
- **f** How much superannuation was paid into Riley's super fund?

☐ I can convert between annual, monthly, fortnightly, weekly and hourly rates of earnings [Complex].

10 Bethany earns $48 700 p.a. Calculate her income per:
- **a** week **b** fortnight **c** month
- **d** If Bethany works for 38 hours each week, calculate her hourly income.

11 Harrison earns $5240 per month. Calculate his weekly income.

☐ I understand how to use tax tables to determine PAYG tax for periodic (i.e. weekly, fortnightly or monthly) earnings [Complex].

12 Given these weekly incomes, use the weekly tax table shown in the interactive textbook to identify how much tax each person will pay if they all claimed the tax-free threshold.
- **a** $178 **b** $350 **c** $433 **d** $518

☐ I can apply the concepts of taxable income, gross income, allowable deductions and levies [Complex].

13 Explain the term gross income compared with net income.

14 Calculate Joanne's taxable income, given that she earned a gross income of $39 550 p.a. and has claimed these tax deductions: $176 for donations to registered charities, $95 for uniform, $6.80 for weekly dry cleaning of her uniform, and 10% of her monthly phone bill, which is $49.

15 Calculate how much money Joanne would contribute to Medicare on the taxable income you worked out in Question **14**.

☐ I can calculate an income tax return, using current tax rates [Complex].

16 Willem's gross income was $61 264 and total tax witheld was $15 300. He does not have private health insurance and his tax deductions total $1374. Calculate the amount that Willem should receive as a tax refund or the amount of his tax debt.

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Chapter review

All questions in the Chapter Review are assessment-style.

Simple Familiar

1 Willoughby works casual hours at a corner store after school and on weekends. He completes a total of 5 hours of work on a Saturday and is paid at a rate of $13.95 per hour. Calculate his wage for the day.

2 Jade is paid $24.50 per hour working as a casual employee at The Honey Factory. Refer to her timesheet to calculate:

a how many hours Jade has worked, in total, in the time period shown

b how much Jade will be paid

Timesheet **Name: Jade Kingsley**

Day/Date	Start time	Finish time	Unpaid breaks	Total hours (minus unpaid breaks)
Monday 3/3/19	8 a.m.	1:30 p.m.	Nil	
Tuesday 4/3/19	8:30 a.m.	4:30 p.m.	30 min	7 h 30 min
Thursday 6/3/19	1 p.m.	5 p.m.	Nil	4 h
Friday 7/3/19	10 a.m.	8 p.m.	30 min	
Monday 10/3/19	8:30 a.m.	3:30 p.m.	15 min	
Tuesday 11/3/19	8:30 a.m.	5:30 p.m.	30 min	8 h 30 min
Wednesday 12/3/19	11 p.m.	6 p.m.	30 min	6 h 30 min
Saturday 15/3/19	9 a.m.	1 p.m.	Nil	4 h
			TOTAL	

3 Salim earns $17.80 per hour and typically works for 25 hours per week. During one week, he completed his standard 25 hours and he also worked 3 hours overtime at a rate of time and a half. Calculate Salim's income for that week.

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4 Joseph earns $28.20 per hour as a casual employee. His contract states that he will not be required to work more than 8 hours per shift; however, if he works more than this, he will be paid a penalty rate of time and a half for the extra time completed. Use appropriate calculations to find the missing information (**a** to **i**) on his timesheet below.

Timesheet **Name: Joseph Douglas**

Day	Start	Finish	Total hours	Normal hours	Overtime	Earnings
Monday	7 a.m.	4 p.m.	9 h	8 h	1 h	**a**
Tuesday	7 a.m.	4:30 p.m.	8 h 30 min	8 h	**b**	**c**
Wednesday	1 p.m.	9:45 p.m.	8 h 45 min	8 h	**d**	**e**
Thursday	10 a.m.	8:15 p.m.	9 h 15 min	8 h	1 h 15 min	**f**
Friday	–	–	–	–	–	–
Saturday	8 a.m.	4 p.m.	8 h	8 h	0	**g**
		TOTAL	43.5 h	40 h	**h**	**i**

5 Harper sells beauty products, earning a commission of 20% of her sales. If she sold $7800 worth of products in March, calculate her earnings for that month.

6 Brandon works in insurance sales and earns a retainer of $3335 per month plus commission of 4% on any insurance products sold. If he sells products to the total of $24 570, calculate his income for the month.

7 Summer knits beanies and scarves for a group of aged care centres. She is paid $8.50 per scarf and $6.00 per beanie that she knits. If Summer makes 55 scarves and 80 beanies, calculate her income.

8 Elizabeth is 17 years old. Calculate the amount of superannuation her employee must contribute for each of these circumstances.

a Elizabeth earns a total of $397.00 in February.

b During school holidays, Elizabeth works 28 hours per week, earning herself $1999 in the month of June.

c During school holidays, Elizabeth works 31 hours per week, earning herself $2345.90 in the month of January.

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9 Refer to Allan's PAYG summary to answer the following questions.

PAYG payment summary – individual non-business

Payment summary for year ending 30 June 2019

Period during which payments were made: **1/07/2018** to **30/06/2019**

Allan McArthur
9 Oakmont Drive
Townsville QLD 4810

Payee's tax file number: **121567898**

TOTAL TAX WITHHELD $ **15,300**

		Lump sum payments	
Gross payments	$ **61,264**	A $	**0**
CDEP payments	$ **0**	B $	**0**
Reportable fringe benefits amount FBT Year 1/04/18 to 31/03/19	$ **0**	D $	**0**
Reportable Employer Superannuation Contributions	$ **0**	E $	**0**
Total Allowances	$ **0**		

- **a** Determine whether or not Allan has provided a TFN to his employee.
- **b** Explain the consequence of someone not providing a TFN.
- **c** Identify how much tax Allan's employer withheld from his pay.
- **d** Identify Allan's gross payment amount.
- **e** Calculate his net pay for the year.
- **f** Determine if Allan's employer made any extra superannuation contributions for the year.
- **g** Calculate how much Allan's employer would have contributed in compulsory superannuation.

Complex Familiar

10 George and Roberta are comparing their incomes. George works in a service station 25 hours per week and is paid $21.65 per hour. Roberta manages a sporting goods store part-time for 26 hours per week, earning $1130 per fortnight. Calculate who earns the most income per hour.

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11 Simon has two part-time jobs. His first job, working in a music store, pays him a gross income of $3609.67 per month, for which he does not claim the tax-free threshold. Simon's second job, fixing computers, pays him a gross income of $646 per fortnight, for which he does claim the tax-free threshold. Using the following tables, calculate the amount of money Simon earns per annum, after tax has been withheld.

Monthly tax table

	Amount to be withheld	
Monthly earnings 1 $	**With tax-free threshold 2 $**	**No tax-free threshold 3 $**
3232.67	407.00	936.00
3237.00	412.00	936.00
3241.33	412.00	936.00
3245.67	412.00	940.00
3250.00	416.00	940.00

	Amount to be withheld	
Monthly earnings 1 $	**With tax-free threshold 2 $**	**No tax-free threshold 3 $**
3601.00	537.00	1062.00
3605.33	537.00	1066.00
3609.67	542.00	1066.00
3614.00	542.00	1066.00
3618.33	542.00	1070.00

Fortnightly tax table

	Amount to be withheld	
Fortnightly earnings 1 $	**With tax-free threshold 2 $**	**No tax-free threshold 3 $**
642.00	—	144.00
644.00	—	144.00
646.00	—	146.00
648.00	—	146.00
650.00	—	146.00

	Amount to be withheld	
Fortnightly earnings 1 $	**With tax-free threshold 2 $**	**No tax-free threshold 3 $**
812.00	20.00	194.00
814.00	20.00	196.00
816.00	20.00	196.00
818.00	20.00	196.00
820.00	22.00	198.00

12 Calculate the amount of money that can be claimed as a tax deduction for each of the following expenses.

a 578 km at 66 cents per kilometre

b 25% of a $79 monthly phone plan

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13 Sebastian works from home as a bookkeeper. He earns $490.80 per week.

a Calculate Sebastian's annual gross income.

b Sebastian has a room in his house set up as an office for his job. This room takes up 12% of the total area of the house. Sebastian's total household expenses are $10 750 p.a. Calculate how much he can claim as a tax deduction for this.

c Sebastian has other tax deductions that include 40 km of work-related car expenses per week, stationery costs of $164 for the year, and he has receipts to show he has donated $470 to registered charities this year. Calculate Sebastian's taxable income for the year.

14 Given that the Medicare levy is 2% of a person's taxable income, calculate the amount of Medicare levy to be paid by the following taxpayers, who each has health insurance.

a a dental assistant with a taxable income of $35 650

b a carpenter with a taxable income of $41 760

c a kitchen chef with a taxable income of $49 200

15 Refer to the table provided to calculate the total Medicare levy that these employees must pay if they do *not* have private health insurance and are single.

a a marketing manager with a taxable income of $86 500

b an insurance broker with a taxable income of $103 040

c a service delivery manager with a taxable income of $138 300

d a managing director with a taxable income of $149 633

Income thresholds for Medicare levy surcharge rates

	Threshold	Tier 1	Tier 2	Tier 3
Singles	$90 000 or less	$90 001–$105 000	$105 001–$140 000	$140 001 or more
Families	$180 000 or less	$180 001–$210 000	$210 001–$280 000	$280 001 or more
Rates	0.0%	1.0%	1.25%	1.5%

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16 Conrad is a marine fisherman earning $69 550 p.a. Last financial year he had deductions that included $195 for tools, $45 for sunscreen and he donated $970 to registered charities. He has private health insurance and pays the 2% Medicare levy. Using the ATO's tax rates table shown, calculate his total tax payable.

Resident tax rates 2018–19

Taxable income	Tax on this income
0–$18 200	Nil
$18 201–$37 000	19c for each $1 over $18 200
$37 001–$90 000	$3572 plus 32.5c for each $1 over $37 000
$90 001–$180 000	$20 797 plus 37c for each $1 over $90 000
$180 001 and over	$54 097 plus 45c for each $1 over $180 000

17 Elanor's payment summary is shown. She has private health insurance and her taxable deductions totalled $776.

PAYG payment summary – individual non-business

Payment summary for year ending 30 June 2019

Period of Payment: Day/Month/Year **01/07/2018** to Day/Month/Year **30/06/2019**

Elanor Thompson
9 Tintaldra Street
Buderim QLD 4556

Payee's tax file number: **12459890**

TOTAL TAX WITHHELD $17,800

		Type		Lump Sum Payments	Type
Gross payments	$ 68,574	S	A $	0	
CDEP payments	$ 0		B $	0	
Reportable employer superannuation contributions	$ 0.00		D $	0	
Reportable fringe benefit amount FBT year 1 April to 31 March	$ 0.00		E $	0	

a Calculate Elanor's taxable income.
b Calculate the income tax payable she must pay.
c Calculate the Medicare levy and the total tax payable she must pay.
d Calculate the amount that Elanor should receive as a tax refund or the amount of her tax debt.

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Complex Unfamiliar

18 Cody's base taxable income is $4329 per month. He also earned $3800 extra throughout the past financial year working overtime, for which he was paid a penalty rate of 165%. Cody does not have private health insurance. Calculate his total income and, hence, his total Medicare levy for the year.

19 Cooper's group certificate is shown.

PAYG payment summary – individual non-business
Payment Summary for Year Ending 30 June 2019

Period of payment Day/Month/Year **01/07/2018** to Day/Month/Year **30/06/2019**

Cooper McCarthy
17 Tintaldra Rd
Bundaberg QLD 4670

Payee's tax file number **54567876**

TOTAL TAX WITHHELD $ **12,176**

		Lump sum payments	Type
Gross payments	$ **57,860**	A $	
CDEP Payments	$	B $	
Other Payments	$	D $	
Reportable fringe benefits amount FBT Year 1 April to 31 March	$	E $	
Reportable Employer Superannuation Contribution	$ **0**		

Cooper does not have private health insurance and his tax deductions include:

- sunscreen $20
- hat $30
- Ray-Ban sunglasses $185
- dry cleaning $16.50 per month
- travel expenses of 792 km at 66 cents per km
- personal phone, for which he pays $79 per month and uses 40% of the time for work.

Using the ATO's tax tables given in Question **16**, calculate the amount that Cooper should receive as a tax refund or the amount of his tax debt.

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9 Budgeting

Maths for a homemaker: Justine Lea

Justine Lea completed a Business degree and pursued a career in sales and marketing before going on to become a teacher and now a stay-at-home mum. She has two children that are not yet school age and she spends her time taking them to activities and runs the household while her husband works full-time.

Tell us a bit about your job. What does a typical day look like?

Although currently I am a stay-at-home mum, I often find I feel busier these days than when I worked full-time! My two sons are under the age of 3 years and they keep me very busy. Between entertaining them and maintaining the everyday household chores plus attending other activities like playgroup and swimming lessons, I find that the days fly by. I love spending time with my boys and watching all the little changes and growth that takes place in them on a daily basis.

What maths did you study at school?

I studied Maths A (General Maths) in school and I quite enjoyed the challenge and structure that maths brings.

How do you use maths in your job?

I use maths almost daily. Being a stay-at-home mum is very expensive and it means that my husband and I have to be on a very tight budget. So I have to ensure that when I do grocery shopping that I get items that are on sale or that we have allowed for in our budget. I am also conscious of keeping our utility bills to a minimum, to ensure we do not go over our quarterly budget allowance.

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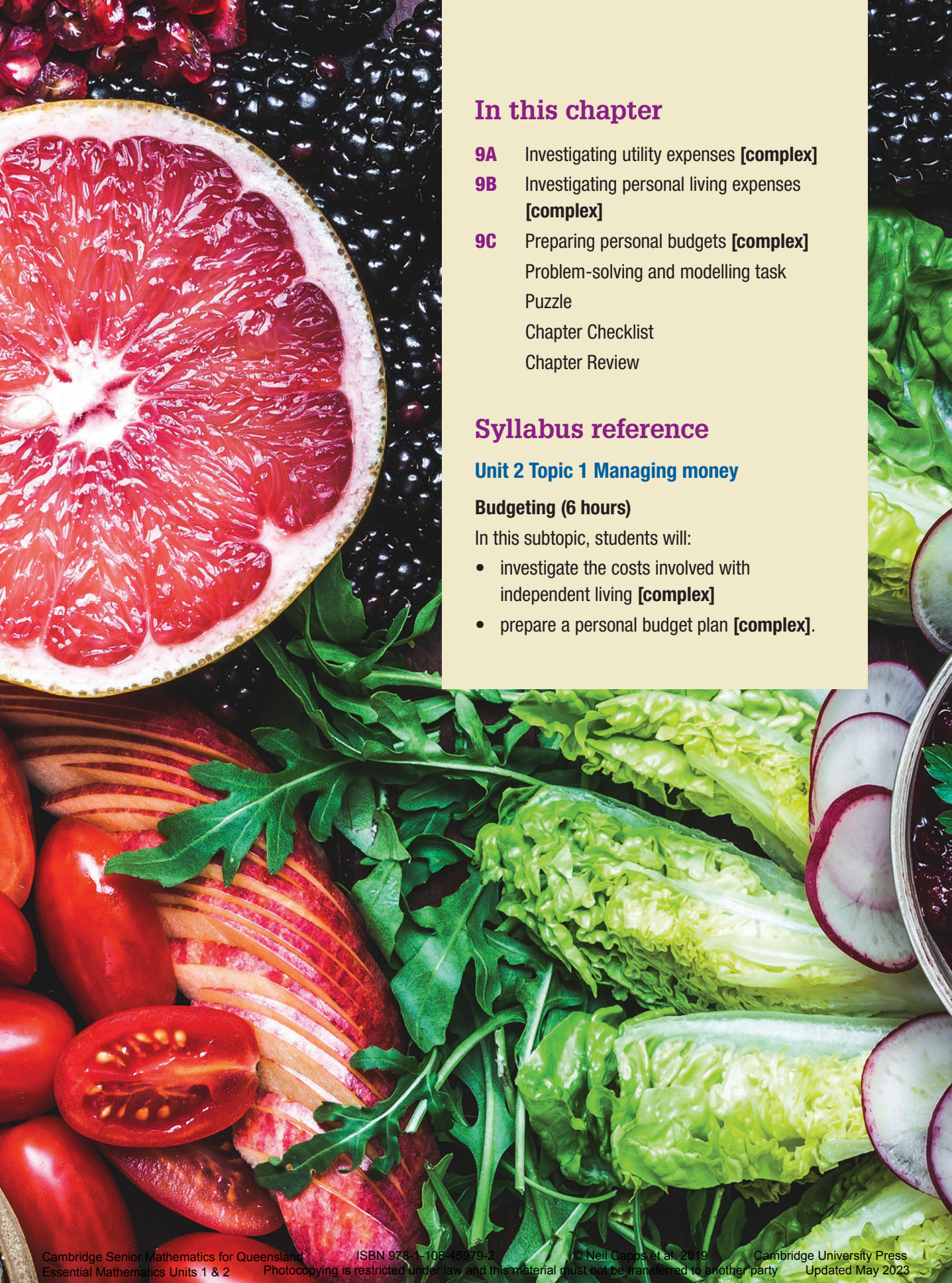

In this chapter

9A Investigating utility expenses **[complex]**

9B Investigating personal living expenses **[complex]**

9C Preparing personal budgets **[complex]**

Problem-solving and modelling task

Puzzle

Chapter Checklist

Chapter Review

Syllabus reference

Unit 2 Topic 1 Managing money

Budgeting (6 hours)

In this subtopic, students will:

- investigate the costs involved with independent living **[complex]**
- prepare a personal budget plan **[complex]**.

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Pre-test

1 The table shows Elisa's weekly expenses.

Expenses	Amount
Food	$137
Health insurance	$21
Phone	$15
Utilities	$15
Room rent	$250
Entertainment	$97

a How much money does Elisa spend per week?

b Elisa works 25 hours and earns $25 per hour. Can she support her current lifestyle with her current wage?

c Elisa wishes to reduce her hours to have more time to study. How much can she reduce, to the nearest half hour, so that she can still support her current lifestyle?

d If Elisa wishes to reduce her hours even more, how do you suggest she can keep supporting herself?

2 Convert the frequency of payment to the frequency mentioned in the bracket.

a $160 per day (weekly)

b $45 678 per year (weekly)

c $832 per fortnight (yearly)

d $543 per week (monthly)

3 Raj is deciding between multiple companies for car insurance. He can choose between: Alliance for $875 per year; CARmi for $450 per half year; or MRNA for $18 per week. Which of the three companies provides the cheapest option?

4 Yue currently must pay $2250 per year for car expenses, $40 per month for her phone plan and $500 per fortnight for rent. She wishes to convert all these payments to a weekly frequency for convenience. How much does she pay each week for these expenses?

5 Carrie works 40 hours a week for $31.50 per hour. However, she must set aside $12 841 per year for tax and an additional 2% of her income for the Medicare levy. How much does she have left per week?

6 The table shows Horace's expenses. Horace earns $42 000 per year.

Expenses	Amount
Food	$137 per week
Health insurance	$99 per month
Phone	$50 per month
Utilities	$430 per quarter
Room rent	$800 per fortnight
Entertainment	$88 per week
Tax	15% of income

a How much does Horace earn each week?

b How much does he spend on everything (excluding tax) each week?

c Including tax, how much money does Horace save/lose each year?

d If only $39 000 of his income is taxable, how much money does Horace save/lose each year?

A link to a HOTmaths lesson is provided in the Interactive Textbook to revise this topic.

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9A Investigating utility expenses COMPLEX

LEARNING GOALS

- Read a utility bill
- Convert between weekly, fortnightly, monthly and yearly charges

Why is it essential to understand and pay utility bills?

What are utilities? Utilities are essential services, such as power and water, provided to every household and business. Utility bills are regularly invoiced to the property owner and include power bills, council rates for water and garbage services, and internet and phone bills. If a utility bill is not paid within a certain time, then the essential service is likely to be stopped.

Most utility bills are calculated according to usage. By reading and understanding these bills, it is possible to learn how to reduce some costs, such as using less power during peak periods.

A meter reader records power usage. You can keep your own monthly record by subtracting the kWh readings of the first and last days of the month.

WHAT YOU NEED TO KNOW

- Electricity usage is measured in **kilowatt hours**, **kWh**. 1 kWh is the equivalent of 1 kilowatt (i.e.1000 watts) of power used for 1 hour.
  - For example: 1 kWh is equal to a 1000 W iron being used for 1 hour or a 500 W washing machine being used for 2 hours or a 2000 W hair dryer being used for $\frac{1}{2}$ an hour.
- Electricity usage is charged in cents per kilowatt hour, ¢/kWh. Electricity rates vary between power suppliers but there are generally two categories:
  - **Off peak rate** is charged during the daytime when there is less demand for electricity, and the rate is cheaper. The actual time periods vary between companies.

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  - **Peak rate** is charged during the time of higher electricity demand, and is charged at a higher rate. Peak time typically applies from around 2 p.m. to 8 p.m. but peak-time periods also vary between companies.
- Water usage charge is based on the volume of water used and this is recorded at each property's water meter. This charge covers the cost of a council buying treated water from the Queensland Government.
- Council rates are charged to property owners based on the value and purpose of their land. These rates are then used to fund services and facilities within the locality, such as roads, parks, gardens, rubbish disposal, and sport and library facilities.
- Phone and internet costs vary, depending on the provider. There are a variety of pricing plans available, typically charged per month, though a contract may lock the customer into plan for a year or more. The total charge per month is calculated from the number and type of phone calls and the quantity of data downloaded.
- Relationships between time periods

7 days per week	52 weeks per year
14 days per fortnight	26 fortnights per year
365 days per year	12 months per year

- Converting costs and charges for different time periods: Round all money answers to two decimal places. Where possible, use the daily cost for calculations, as other costs are likely to have been rounded.

$$\text{Weekly cost} = \text{daily cost} \times 7$$
$$\text{Fortnightly cost} = \text{daily cost} \times 14$$
$$\text{Yearly cost} = \text{daily cost} \times 365$$
$$\text{Monthly cost} = \text{daily cost} \times 365 \div 12$$

Example 1 Reading a utility bill

A sample electricity bill is shown.

a Identify the time period for this bill.

b Identify the total cost of this bill.

c Identify the average daily cost for the period of this bill.

d Identify Samantha's average daily kWh usage.

e For the same period of time last year, determine if Samantha has increased or decreased the amount of electricity she used.

f Based on the comparison to other people's homes in her area, estimate the total number of people that live in Samantha's house.

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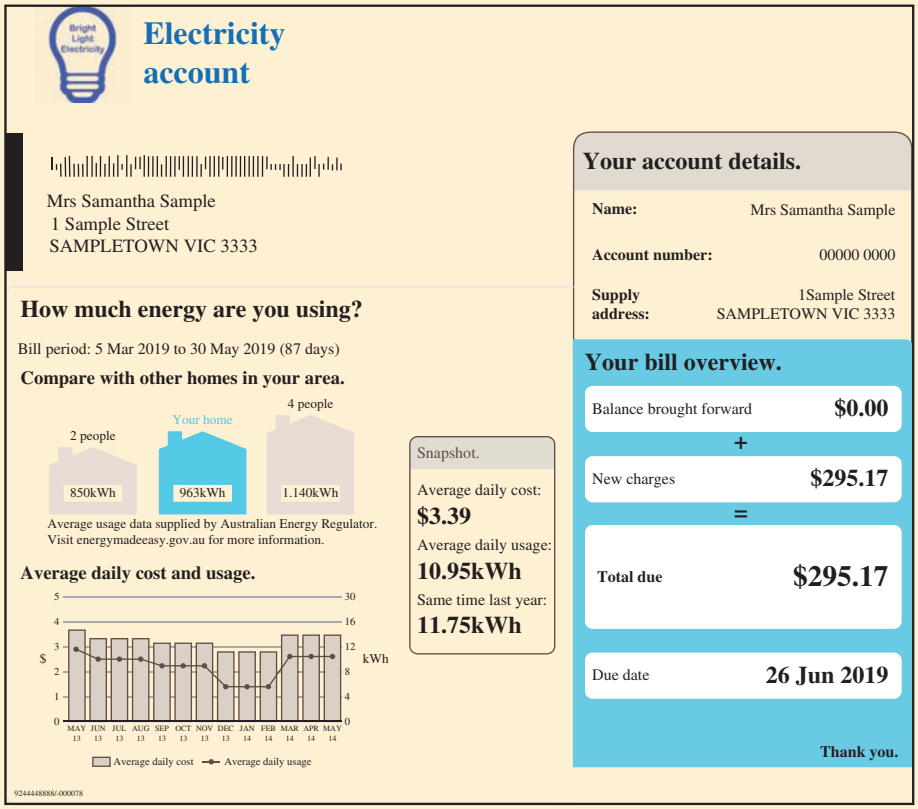

Electricity account

Mrs Samantha Sample
1 Sample Street
SAMPLETOWN VIC 3333

How much energy are you using?

Bill period: 5 Mar 2019 to 30 May 2019 (87 days)

Compare with other homes in your area.

2 people 850kWh
Your home 963kWh
4 people 1.140kWh

Average usage data supplied by Australian Energy Regulator.
Visit energymadeeasy.gov.au for more information.

Average daily cost and usage.

$ 5 4 3 2 1 0
kWh 30 16 12 8 4 0
MAY 13 JUN 13 JUL 13 AUG 13 SEP 13 OCT 13 NOV 13 DEC 13 JAN 14 FEB 14 MAR 14 APR 14 MAY 14
Average daily cost
Average daily usage

Snapshot.
Average daily cost:
$3.39
Average daily usage:
10.95kWh
Same time last year:
11.75kWh

Your account details.

Name:	Mrs Samantha Sample
Account number:	00000 0000
Supply address:	1Sample Street SAMPLETOWN VIC 3333

Your bill overview.

Balance brought forward	$0.00
+	
New charges	$295.17
=	
Total due	$295.17
Due date	26 Jun 2019

Thank you.

9244448888/-000078

WORKING

a 87 days

b $295.17

c $3.39 per day

d 10.96 kWh

e Samantha decreased her average daily usage compared to last year.

f Three people

THINKING

Find the location of this information on the electricity bill.

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Example 2 Converting between weekly, fortnightly, monthly and yearly charges

Use Samantha's average daily electricity cost of $3.39 from **Example 1** to calculate how much she should budget for electricity usage per:

a week **b** fortnight **c** month **d** year

WORKING	THINKING
a $3.39 × 7 = $23.73 per week	Weekly cost = daily cost × 7
b $3.39 × 14 = $47.46 per fortnight	Fortnightly cost = daily cost × 14
c $3.39 × 365 = $1237.35 per year = $1237.35 ÷ 12 per month = $103.11 per month	Yearly cost = daily cost × 365 Monthly cost = yearly cost ÷ 12 = $103.1125 Round money answers to two decimal places.
d $3.39 × 365 = $1237.35 per year	Yearly cost = daily cost × 365 When possible, always start with the daily cost, as other costs are likely to have been rounded.

Exercise 9A

FUNDAMENTALS

1 Demonstrate your understanding of terms by filling in the missing words in the following statements.

a Electricity usage is charged in _____ per _____ _____ (kWh).

b Off-peak electricity rates are _____ and charged when there is _____ demand.

c _____ electricity rates are _____ and charged during the time of _____ demand.

d Water usage charge is based on the _____ of water used and this is recorded at each property's water _____.

e Council _____ are charged to property owners and used to fund _____ and facilities within the locality.

f Fortnightly charge = _____ charge × _____

g Monthly charge = _____ charge × 365 ÷ _____

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APPLICATIONS

SF: – | CF: 2–8 | CU: 9–10

Example 1 ★ 2 Refer to John's electricity bill to answer the following questions.

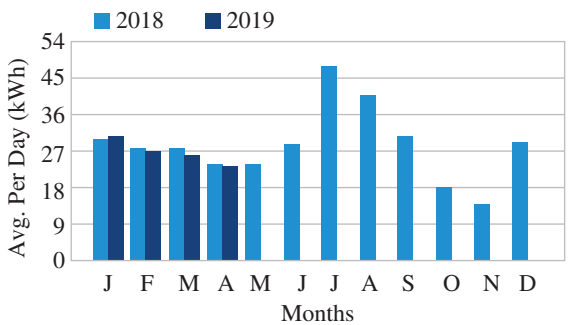
ABC Electricity

Customer: John Stigmal
3 Greenacres Dr
Goondiwindi Qld 4390

Billing Period	Types	Reading
Apr 17	Actual	19 207
Mar 18	Actual	18 509
30 Days	kWh Billed	698

Electricity rate: Energy is charged at $0.1527 per kWh.

Electricity usage



Billing summary

Balance as of 21 April	$0.00
Electricity usage charge	$106.58
Fixed charges	$10.00
Total current charges	$116.58
Amount due by May 12	$116.58
Account balance	$116.58

a For this bill, identify the:
i time period **ii** total cost **iii** cost per kWh **iv** kWh billed.

b Determine whether John used more kWh in January 2018 or January 2019.

★ 3 Refer to Robyn's council rates to answer the following questions.

Customer Name/address: Robyn Stephenson
3 Countrylakes Dr
North Lakes Qld 4509

CUSTOMER ENQUIRIES
Phone: (07) 5475 7542
Email: rates@sunshinecoast.qld.gov.au
Fax: (07) 5441 8338
ABN 37 876 973 913

HALF YEARLY RATE NOTICE FOR PERIOD
1 July 2018 to 31 December 2018

ISSUE DATE	21 July 2018
VALUATION	$ 172,500
REFERENCE	98587214
DUE DATE FOR PAYMENT	**21 August 2018**
NET AMOUNT PAYABLE	**$664.28**

RATES AND CHARGES	UNITS	RATE CHARGED	AMOUNT
Opening Balance			122.46–
General Rate - Catagory 6		Minimum Rate =	555.00
Waste Bin - 240 Litre	1 ×	$271.40 × .5 =	135.70
Heritage Levy	1 ×	$5.00 × .5 =	2.50
Environment Levy	1 ×	$60.00 × .5 =	30.00
Transport Levy	1 ×	$20.00 × .5 =	10.00
State Emergency Management Levy: Class A Group 2	1 ×	$196.40 × .5 =	98.20
Carbon Tax Refund		=	16.91–
Total:			**$692.03**
Discount - (only if paid by 21 August 2018):			$27.75–
Net amount Payable:			**$664.28**

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a Identify:
i time period **ii** total amount **iii** discount if paid on time **iv** valuation.
b What services do the rates and charges that are paid contribute towards?

★ **4** Refer to Peter's water utility bill to answer the following questions.

WATER AND SEWERAGE
YOUR BILL

Company Name: H_2O Supplies
Customer Name/address: Peter McArthur
61 Belvedere Rd
Goondiwindi Qld 4883

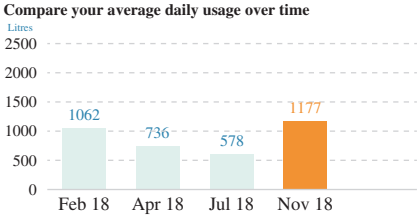
Bill number	7114472298
Billing period 96 days	30 Jul 2018 to 2 Nov 2018
Issue date	5 Nov 2018
Approximate date of next meter reading	1 Feb 2019

Your account activity

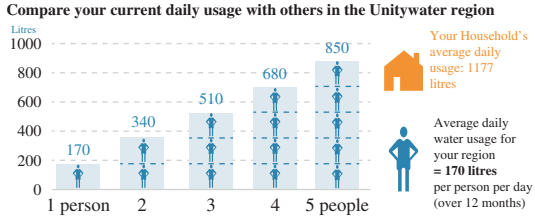
Your last bill	Payments/ adjustments	Balance	New charges	Total due	Due date
$367.22	$367.22	$0.00	$603.98	$603.98	7 Dec 2018

11% interest per annum, compounding daily, will apply to any amount not paid by the due date

Compare your average daily usage over time



Compare your current daily usage with others in the Unitywater region



a Identify the time period for this bill.
b Identify the total amount to be paid for this bill.
c Identify how much Peter paid for his previous bill.
d Consider if there could be a reasonable explanation as to why Peter's water usage is higher in February and November than for the other months and explain why.

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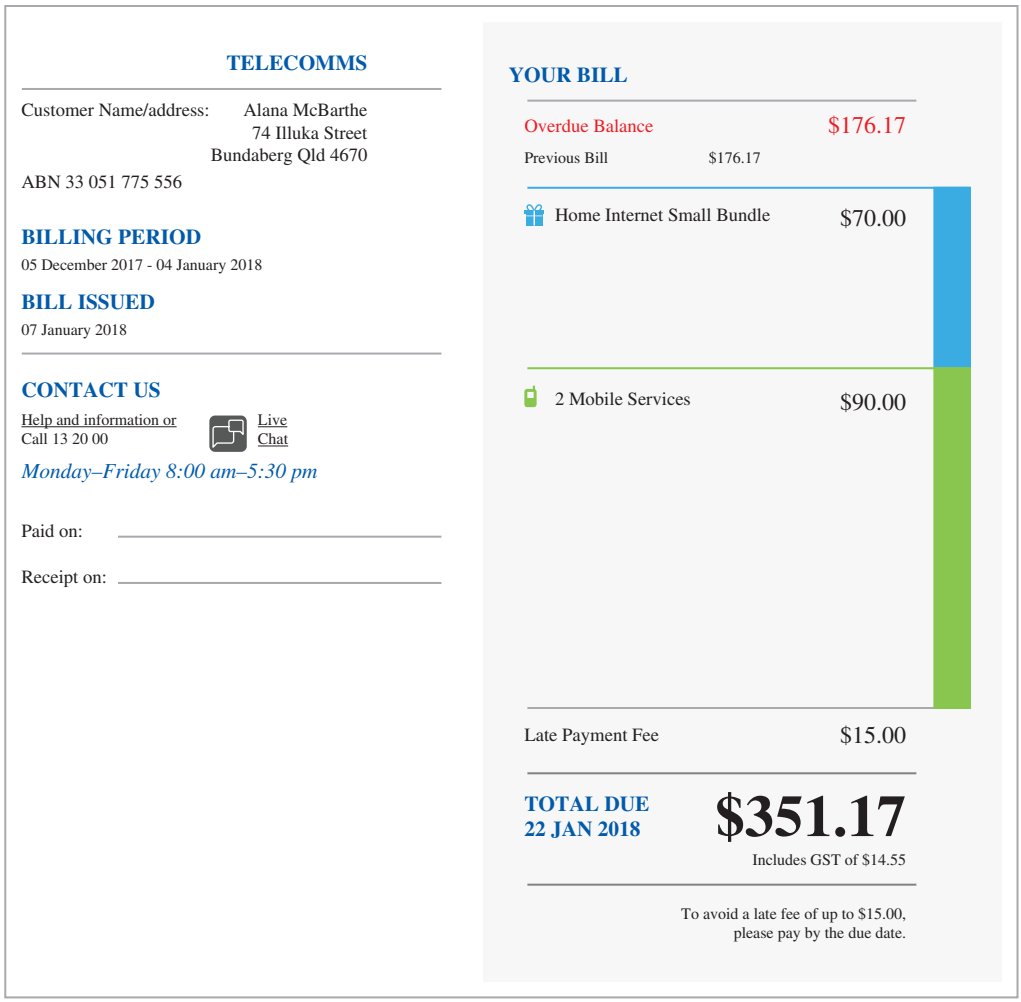
★ **5** Refer to Alana's phone and internet bill to answer the following questions.



TELECOMMS

Customer Name/address: Alana McBarthe
74 Illuka Street
Bundaberg Qld 4670

ABN 33 051 775 556

BILLING PERIOD
05 December 2017 - 04 January 2018

BILL ISSUED
07 January 2018

CONTACT US
Help and information or Call 13 20 00
Live Chat
Monday–Friday 8:00 am–5:30 pm

Paid on: _____

Receipt on: _____

YOUR BILL

Overdue Balance	$176.17
Previous Bill	$176.17
Home Internet Small Bundle	$70.00
2 Mobile Services	$90.00
Late Payment Fee	$15.00
TOTAL DUE 22 JAN 2018	**$351.17**

Includes GST of $14.55

To avoid a late fee of up to $15.00, please pay by the due date.

a Identify the time period for this bill.
b Identify the total amount to be paid for this bill.
c How much was Alana's previous bill?
d How much extra has Alana been charged for not paying her previous bill by the due date?
e Identify how many mobile services are on this bill.
f Calculate the monthly cost of each mobile service.

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Example 2 ★6 Adam's average daily electricity cost is $5.76. Calculate how much he would need to budget for electricity per:

a week **b** fortnight
c month **d** year

Hint: Monthly cost = daily charge × 365 ÷ 12

★7 From Question **3**, we saw that Robyn's council rates bill is $664.28 for a period of 6 months. Calculate how much she would need to allow in her budget for rate payments per:

a year **b** fortnight
c month

Hint: Monthly cost = yearly cost ÷ 12

★8 From Question **4**, we saw that Peter's water bill is $603.98 for a period of 96 days. Calculate how much he would need to allow in his budget per:

a day **b** week
c fortnight **d** year
e month

Hint: Daily charge = total charge ÷ the billing period (in days)

★9 Jaymee's monthly mobile phone bill is displayed. Use the bill's information to calculate how much she would need to allow in her budget per:

a year **b** fortnight **c** week

TAX INVOICE Page 1 of 18

Invoice No: 666936482
Issue date: 10 Jan 18
Invoice period: 09 Dec 17 to 08 Jan 18

Company Name: Optimum Communications Network
Customer Name/address: Jaymee Jones
32 Alberten Way
Maroochydore Qld 4558

LAST BILL	PAYMENTS/ADJUSTMENTS	BALANCE	THIS BILL	TOTAL AMOUNT DUE
$178.78	− $178.78CR	= $0.00	+ $177.77	= $177.77

THIS BILL DUE DATE 27 Jan 18

YOUR RECENT CHARGES

YOUR ACCOUNT SUMMARY $

LAST BILL	$178.78
PAYMENTS & ADJUSTMENTS	$178.78CR
BALANCE	$0.00

THIS BILL

ACCOUNT CHARGES	$1.63
SERVICE CHARGES	
1234567891 on $80 My Plan Plus	$79.99
1234567892 on $80 My Plan Plus	$79.99
1234567893 on Shared Data Plan	$0.00
SUB-TOTAL	$161.61
GST	$16.16
TOTAL THIS BILL	$177.77
Total Amount Due (incuding GST)	$177.77

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★10 Rory has been saving $110 per fortnight for the past six fortnights in order to pay his electricity bill, which he receives every 3 months. Rory's most recent bill is shown. Use the bill's information to answer the following questions.

a Determine if Rory has saved enough money to pay this bill in full.

b Calculate how much money, if any, Rory will have remaining after paying the bill.

c Rory's next bill is due in 3 months' time. Based on the bill shown, calculate how much he should allow in his budget if he was to save per:

i month

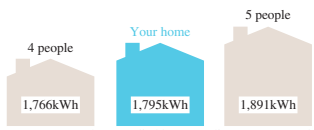
ii fortnight

Company Name: ABC Electrical
Customer Name/address: Rory Jones
37 Quinnstar Court
Roma Qld 4455

How much energy are you using?

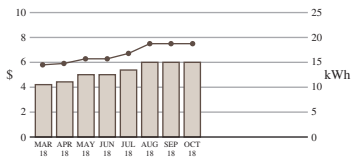
Bill period: 20 Jul 2018 to 23 Oct 2018 (96 days)

Compare with other homes in your area.



Average usage data supplied by Australian Energy Regulator based on homes with average gas usage and no pool during spring. Visit energymadeeasy.gov.au for more information.

Average daily cost and usage.



Snapshot.
Average daily cost: **$6.11**
Average daily usage: **18.70kWh**

Tax Invoice Issuect 26 Oct 2018

Your bill overview.

Balance brought forward	$0.00
+	
New charges	$586.43
=	
Total due	$586.43
Discounted amount if paid by due date	$533.35
Due date	15 Nov 2018

To avoid a late payment fee of $12.73, please pay by the due date.

Thank you.

Many bills can be paid automatically from an online bank account.

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9B Investigating personal living expenses COMPLEX

LEARNING GOALS

- Identify the fixed and variable expenses involved when living independently
- Convert costs of various time periods to yearly costs

Why is it essential to know about living expenses?

Paying for personal living expenses enables independent living. There are many expenses that come with living independently, including utility bills, rent, food, clothing, entertainment, car expenses, and various insurances. Every item needs to be accounted for in a personal budget, to ensure that income will cover living costs and we can afford our chosen lifestyle.

Being unable to pay for living expenses can result in many stressful outcomes, such as having the power disconnected, a car or item repossessed or even being evicted from a rental property.

The financial stress of an unexpected cost or bill can be avoided with a regular savings plan included in your budget.

WHAT YOU NEED TO KNOW

- **Fixed expenses** rarely change in cost over the period of a year, meaning that the price is on a yearly basis, or is fixed by an annual contract. There is limited opportunity to change the cost or make savings during the year. Making changes or savings can generally only be done well in advance, for a year's budget.
  - For example:

Car registration	Car insurance
Internet plan	Rent for accommodation
Private health insurance	Personal loan repayments
Mortgage repayments	House insurance
Mobile phone plan	Council rates

- **Variable expenses** can change in cost, depending on the circumstances. The cost is determined by the quantity consumed, and you have some choice

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to consume more or less, or to shop around during the year around to find cheaper suppliers and make savings.

- For example:

Lunch with friends	Water bill	Concert tickets
Entertainment	Birthday presents	Electricity bill
Coffee at a café	Taxis	Clothing
Car fuel	Groceries	Public transport

- Multiples of various time periods that give 1 year

52×1 week $= 52$ weeks $= 1$ year
26×1 fortnight $= 26$ fortnights $= 1$ year
12×1 month $= 12$ months $= 1$ year
4 quarters $= 4 \times 3$ months $= 12$ months $= 1$ year
2×6 months $= 12$ months $= 1$ year

- Individuals may differ in what they regard as **essential** and **optional costs**. Depending on circumstances there are generally both essential and optional costs within both fixed or variable expenses.

Example 3 Identifying the fixed and variable expenses involved when living independently

Identify which of the following cost of living expenses are:

a fixed expenses b variable expenses

Clothing	Mortgage repayments	Public transport	Lunch with friends
Car fuel	Theme park tickets	Electricity bill	House insurance
Car registration	Private health insurance	Internet plan	Take-away coffee
Car insurance	Mobile phone plan	Water bill	Birthday presents
Groceries	Personal loan repayments	Rent	Concert tickets

WORKING

a Fixed expenses

Car registration	Car insurance
Internet plan	Rent
Private health insurance	Personal loan repayments
Mortgage repayments	House insurance
Mobile phone plan	

THINKING

Fixed expenses are those that are a set amount and generally do not vary throughout the year.

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WORKING	THINKING
b Variable expenses Lunch with friends Theme park tickets Take-away coffee Car fuel Water bill Birthday presents Public transport Groceries Concert tickets Electricity bill Clothing	Variable expenses fluctuate, depending on the circumstances. An electricity bill for the summer period may be higher as a result of using the air conditioner more; the cost of car fuel may be higher a particular week because more kilometres were travelled or the price of fuel per litre was higher.

Example 4 Converting costs of various time periods to yearly costs

Calculate the yearly cost for the following fixed expenses.

a Rent of $415 per week
b Mobile plan of $89 per month
c Private health insurance of $117 per month
d Council rates of $690 for 6 months
e Internet plan $60 per month
f Car insurance of $177 per quarter
g Car registration of $420 for 6 months
h Mortgage repayments of $912.50 per fortnight

WORKING	THINKING
a $\$415 \times 52 = \$21\,580$	Yearly cost = weekly cost × 52
b $\$89 \times 12 = \$1068$	Yearly cost = monthly cost × 12
c $\$117 \times 12 = \$1404$	Yearly cost = monthly cost × 12
d $\$690 \times 2 = \$1380$	Yearly cost = 6 monthly cost × 2
e $\$60 \times 12 = \$720$	Yearly cost = monthly cost × 12
f $\$177 \times 4 = \$708$	Yearly cost = quarterly cost × 4 A quarter of a year = 3 months, so 4 × 3 months = 12 months
g $\$420 \times 2 = \$840$	Yearly cost = 6 monthly cost × 2
h $\$912.50 \times 26 = \$23\,725$	Yearly cost = fortnightly cost × 26

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Exercise 9B

FUNDAMENTALS

1 Demonstrate your understanding of terms by filling in the missing words in the following statements.

- **a** Fixed _____ rarely change in cost over a year.
- **b** Car registration, rent, loan repayments and insurance are all examples of _____ living expenses.
- **c** _____ living expenses can change in cost.
- **d** The cost of electricity, fuel, transport and groceries can _____ during the year.
- **e** __ quarters = 4 × (__ months) = __ months = 1 year
- **f** __ fortnights = 1 year
- **g** __ × (6 months) = 1 year

Example 3

2 Identify the following as either a fixed (F) or a variable (V) expense.

- **a** Petrol
- **b** Electricity
- **c** Private health insurance
- **d** Water bill
- **e** Rent
- **f** Mortgage repayments
- **g** House insurance
- **h** Clothing
- **i** Gifts
- **j** Phone plan
- **k** Going out to dinner with friends
- **l** Council rates
- **m** Car registration
- **n** Going to see a movie
- **o** Food
- **p** Shoes
- **q** Public transport
- **r** Car insurance
- **s** Internet plan
- **t** Personal loan repayments
- **u** Coffee at a café
- **v** Rugby union tickets

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3 Decide whether each of these statements is true or false. Give a reason for each answer.

- **a** Fixed expenses are associated with a cost that is a set amount and very rarely fluctuates.
- **b** Fixed expenses are typically costs that a person is not able to adjust when creating a budget (except when creating a budget, well in advance, for a year).
- **c** Variable expenses are associated with a cost that can change from time to time and can depend on circumstances, including the weather.

APPLICATIONS

SF: –	CF: 4–6	CU: 7, 8

Example 4 ★**4** Calculate the yearly cost for the following fixed expenses.

- **a** Rent $310 per week
- **b** Mobile plan $79 per month
- **c** Private health insurance $149 per month
- **d** Car registration $540 for 6 months
- **e** Mortgage repayments $1189.70 per fortnight
- **f** House insurance $88 per month
- **g** Rates $875 for 6 months
- **h** Internet plan $59 per month
- **i** Car insurance $290 per quarter

Hint A quarter of a year = 3 months

★**5** The table shows Michael's weekly expenses. Use the information to complete the following.

- **a** Calculate the cost of Michael's weekly fixed expenses.
- **b** Calculate the cost of his weekly variable expenses.
- **c** Should Michael decide to start saving some money per week, suggest some expenses that he could reduce. Explain your choices.

Michael's weekly expenses	
Rent of apartment	$320
Electricity	$80
Phone	$20
Health insurance	$35
House contents insurance	$18
Car registration	$21
Car insurance	$17
Petrol	$60
Food	$150
Clothing	$20
Entertainment	$100
Water	$12
Total	$853

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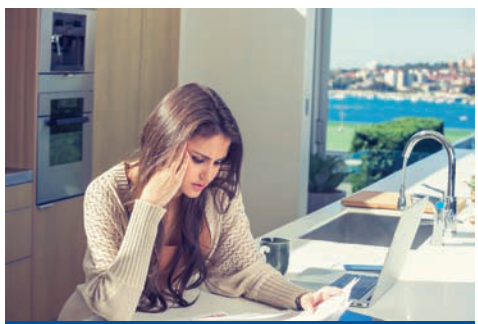
★6 Use the costs in the table to prepare a fortnightly expense budget for Tom.

Item	Cost and period
Rent	$1676.60 per month
Food	$140 per week
Electricity	$480 per quarter
Phone plan	$89 per month
Car registration	$860 per year
Car insurance	$790 per year
Petrol	$70 per week
Health insurance	$175 per month
Contents insurance	$225 per year
Clothes	$100 per month
Entertainment	$150 per month

★7 Alyssa is comparing the quotes she received from two different car insurance providers: We Help at $17.80 per week or Insurance4u at $75.20 per month. Both companies provide the same level of cover. Determine the most suitable company for Alyssa to go with, given that her yearly budget allows approximately $900 per year for this expense. Justify your conclusions with calculations.



The details of insurance quotes will show whether each company covers the same repair and/or replacement costs.

★8 Ryan thinks that he has found the perfect house to rent. However, the weekly rent is $30 more than he has anticipated. His current expenses are:

$100 per week on entertainment
$60 per week on petrol
$16.50 per week on car registration
$48 per week repayment of a personal loan

Advise Ryan on which expenses he could adjust to afford the rental property. Justify (i.e. give reasons for) your advice.

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9C Preparing personal budgets COMPLEX

LEARNING GOALS

- Calculate monthly savings
- Create a personal budget

Why is it essential to budget your money?

With the cost of living being so high, it is essential to create a personal budget that compares living costs with annual income, thus ensuring that you can pay for your chosen lifestyle. Budgeting also helps a person to take control of spending, to save in advance for essential expenses and to monitor optional expenses.

By avoiding debt, individuals can plan for longer-term financial goals such as saving for a car or a holiday, or the deposit for a house or apartment, or starting their own business.

If you are planning to run your own business, creating and following a budget will be critical to your success.

WHAT YOU NEED TO KNOW

- **Savings** are made when expenses are less than income and are calculated as income minus expenses.
- A **budget** should state:
  - time period it covers
  - income during the time period from all sources (after or excluding taxes)
  - all expenses (may be divided into fixed and variable expenses) for the time period including calculations, usually in a table or spreadsheet
  - a calculation of income minus expenses, if a positive value, this is savings, if a negative value this is a shortfall that must be covered, e.g. by withdrawing cash from previous savings.
- Time periods in 1 year

  In 1 year there are:

365 days	12 months
52 weeks	four quarters (of 3 months each)
26 fortnights	two periods of 6 months

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- Conversion calculations

Budget purpose	Convert from	Operation	Converts to
Weekly budget	Monthly cost	× 12 ÷ 52	Weekly cost
	Yearly cost	÷ 52	Weekly cost
Monthly budget	Weekly cost	× 52 ÷ 12	Monthly cost
	Yearly cost	÷ 12	Monthly cost
Yearly budget	Weekly cost	× 52	Yearly cost
	Monthly cost	× 12	Yearly cost

- Symbols used
  - p.a. means per annum; that is, per year.
  - p/m means per month. (Remember: the forward slash (or solidus) means 'per'.)

Example 5 Calculating monthly savings

Marco has calculated that his monthly budget expenditure is $4178 per month. His yearly net income is $50 592. Determine how much money Marco will be able to save at the end of each month.

WORKING	THINKING
$50 592 ÷ 12 = $4216 income per month	Monthly income = yearly income ÷ 12
$4216 – $4178 = $38 per month	Subtract monthly expenses from monthly income.

Example 6 Creating a personal budget

Willow's net income is $41 270 p.a. She has listed her expenditures below. Use the information to calculate:

a Willow's total monthly expenses

b the amount she can save per month

Living expenses

Rent $280 per week
Car loan $52 per week
Electricity bills $20 per week
Mobile phone plan $79 per month
Gifts $40 per month
Contents insurance $792 per year
Entertainment $70 per week
Food $100 per week
Water bills $15 per week
Car registration $840 per year
Petrol $50 per week
Clothes $100 per month

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WORKING

a Income = \$41 270 ÷ 12
= \$3439.17 per month

Expenses:	
Rent = \$280 × 52 ÷ 12 = \$1213.33 p/m	Entertainment = \$70 × 52 ÷ 12 = \$303.33 p/m
Car loan = \$52 × 52 ÷ 12 = \$225.33 p/m	Food = \$100 × 52 ÷ 12 = \$433.33 p/m
Electricity bills = \$20 × 52 ÷ 12 = \$86.67 p/m	Water bills = \$15 × 52 ÷ 12 = \$65 p/m
Mobile phone plan = \$79 p/m	Gifts = \$40 p/m
Car registration = \$840 ÷ 12 = \$70 p/m	Petrol = \$50 × 52 ÷ 12 = \$216.67 p/m
Contents insurance = \$792 ÷ 12 = \$66 p/m	Clothes = \$100 p/m

Total expenses per month = \$2898.66

b \$3439.17 – \$2898.66 = \$540.51 per month savings

THINKING

Income is \$41 270 p.a.
Monthly net income
= yearly net income ÷ 12

Expenses:
Rent \$280 p/w
Car loan \$52 p/w
Electricity \$20 p/w
Mobile phone \$79 p/m
Gifts \$40 p/m
Cont. insurance \$792 p.a.
Entertainment \$70 p/w
Food \$100 p/w
Water \$15 p/w
Car reg. \$840 p.a.
Petrol \$50 p/w
Clothes \$100 p/m

Add all monthly expenses:
\$1213.33 + \$225.33 + \$86.67 + \$79 + \$40 + \$66 + \$303.33 + \$433.33 + \$65 + \$70 + \$216.67 + \$100 = \$2898.66

Income − Expenses = Savings

Exercise 9C

FUNDAMENTALS

1 Demonstrate your understanding of terms by filling in the missing words in the following statements.

a monthly cost × __ = yearly cost
b yearly cost ÷ __ = weekly cost
c monthly cost × __ ÷ __ = weekly cost
d weekly cost × __ = yearly cost
e yearly cost ÷ __ = monthly cost
f weekly cost × __ ÷ __ = monthly cost

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2 Expenses are $875 per week. Income is $1790 per fortnight. Calculate whether income is enough to cover living expenses.

Hint 2 weeks = 1 fortnight

APPLICATIONS

SF: –	CF: 3–7	CU: 8–11

Example 5 ★**3** Matt has calculated that his monthly budget expenditure is $3720 per month. His annual net income is $48 240. Calculate how much money Matt will be able to save at the end of each month.

Regular deposits to a separate account can allow for optional spending.

★**4** Noelle's budget shows that she has a total expenditure of $1260 per fortnight. Her net income is $1374.50 per fortnight. Calculate how much money Noelle will be able to save over the year.

Hint 26 fortnights = 1 year

★**5** Raoul has just started a new job as a chef. He has prepared the following monthly budget.

Description	Amount
Car	$320
Rent	$1200
Utilities	$110
Education debt	$200
Groceries	$400
Credit card	$180
Health insurance	$180
Other	$500

a Calculate Raoul's total monthly expenses.

b Raoul's annual net or take-home income is $52 200. Calculate his monthly net income.

c Raoul wishes to save for a holiday, which he plans to take in 12 months' time. Determine how much he would be able to save if he sticks to his budget.

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★6 Sailee is in Year 11 and lives at home with her parents. She currently works part-time in a department store and earns a net income of $178 per week.
Calculate Sailee's weekly savings after she deducts her living costs, given her current living expenses include:
$12 per week for public transport
$20 per week on extra food/drinks
$59 per month for her mobile plan
$150 per month on clothes/accessories
$20 per week on entertainment
$30 per month for gifts
$180 per year for sponsoring a koala through WWF.

Junior employees are considered to be those aged under 21 years, and are paid a percentage of the adult award pay rate.

★7 Andrew is a university student who rents a room and does not own a car, so he catches public transport. He works part-time at a sushi bar and his net income is $830 per fortnight.
Calculate whether Andrew earns enough money per fortnight to cover his living expenses, which are:

$175 per week for rent
$100 per week for food
$50 per week on entertainment
$65 on a monthly bus pass
$120 per month on utilities
$49 per month on his phone plan
$150 every 3 months on clothes
$600 for a flight home once a year

Example 6 ★8 Isla's net income (i.e. after tax is paid) is $54 700 p.a. and she has the following expenditures.

Mortgage $1999 per month
Car loan $48 per week
Electricity bills $25 per week
Rates $920 per 6 months
Food $140 per week
House insurance $97 per month
Mobile phone and internet bundle $89 per month
Entertainment $100 per week
Petrol $60 per week
Water bills $15 per week
Car registration $870 per year
Clothes $100 per month
Charity donation $58 per month
Private health insurance $117 per month

Use the information to calculate:
a Isla's total expenses per month
b how much Isla could possibly save per month

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★9 Finnley has been offered his dream job of working in graphics design. Unfortunately, it is only a part-time position and he would need to leave his current full-time position, which would decrease his monthly income.
Finnley's new job pays a net monthly income of $3120 but he needs to make sure it covers the cost of his living expenses. Use the following information to answer the questions.
Finnley's living expenses:

Rent $415 per week	Entertainment $80 per week
Car registration $98 per year	Food $115 per week
Electricity bills $20 per week	Petrol $120 per fortnight
Mobile phone plan $99 per month	Clothes $80 per month

a Calculate how much money Finnley would have in credit or debit at the end of the month if he accepts the new position and lives off the new wage.

b Suggest some expenses that Finnley could reduce to ensure that he can accept the new part-time job in graphics design.

★10 Annice is trying to save $3200 for an overseas holiday to Bali. She earns a net income of $41 570 p.a. Using the expenditure information presented, create a weekly budget for Annice and calculate the number of weeks that she will need to save to achieve her goal.
Annice's living expenses:

Mortgage $320 per week	Council rates $890 per 6 months
Pet insurance $7.50 per week	Entertainment $60 per week
Electricity bills $24 per week	Food $130 per week
Mobile phone plan $49 per month	Water bills $18 per week
Internet $10 per week	Car registration $620 per year
Petrol $70 per week	Private health insurance $23 per week
Clothes $500 per year	Charity $200 per year
Contents insurance $58 per month	

★11 Joseph is saving to buy a new car that costs $29 800. He does not want to buy it with a loan, as he knows that it will cost him so much more in the long run. So far, he has saved $10 500 and he earns a net income of $68 399 p.a.
Using the expenditure information presented, create a monthly budget for Joseph and calculate the number of months that he will need to save to achieve his goal.
Joseph's living expenses:

Rent $440 per week	Food $130 per week
Sponsor child $62 per month	Water bills $22 per week
Electricity bills $37 per week	Car registration $870 per year
Mobile phone plan $99 per month	Petrol $75 per week
Gifts $50 per month	Clothes $1500 per year
Entertainment $150 per week	
House and contents insurance $112 per month	

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Problem-solving and modelling task

PERSONAL BUDGET

Background: Creating a personal budget is a valuable life skill for everyone who manages their own money.

Task: Your task is to create a weekly personal budget, assuming you have moved out of home. You will be earning the minimum full-time wage, which is net $616.90 per week. There are around 1.8 million Australians living on this income.

You are required to research the average costs of all your living expenses and gather some utility bills as supporting material. Interview your family members to discover other likely living expenses.

You will also need to research the cost of renting a 1- or 2-bedroom home in your chosen locality. With this information, create a complete budget that details all your weekly income and expenses, and conclude with some options for possible weekly savings.

To complete this task, follow the problem-solving workflow diagram given and use the steps listed as a guide.

Independent living requires careful money management.

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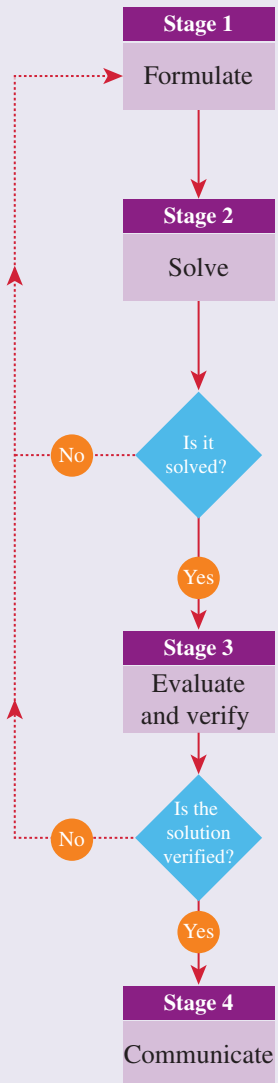

Stage 1: Formulate

1 Plan the research, discussions or relevant observations you will need to create a list of expenses involved in making a personal budget.

Stage 2: Solve

2 Start the personal budget by listing the expenses under the subheadings of variable or fixed.
3 Decide on an area to rent in and find a house or unit listed for rent there to use as the rental costs.
4 Research and set average costs for each of the variable and fixed expenses.
5 Convert all expenses to weekly amounts.
6 Add the total weekly expenses and subtract from the weekly income.

Stage 3: Evaluate and verify

7 Check that you have not spent more than your income. If so, look at some variable expenses. Are there any that can be reduced?
8 Are all the amounts you have allowed reasonable?
9 Will you have money left over to save for an emergency situation (e.g. your car breaks down) or to save towards a goal such as a holiday or buying a car?

Stage 4: Communicate

10 Communicate your budget in the form of a table or spreadsheet that lists the income, all the expenses and the total amount remaining each week.
11 Share and compare your budgets with classmates and discuss any differences and whether they have discovered any other savings.

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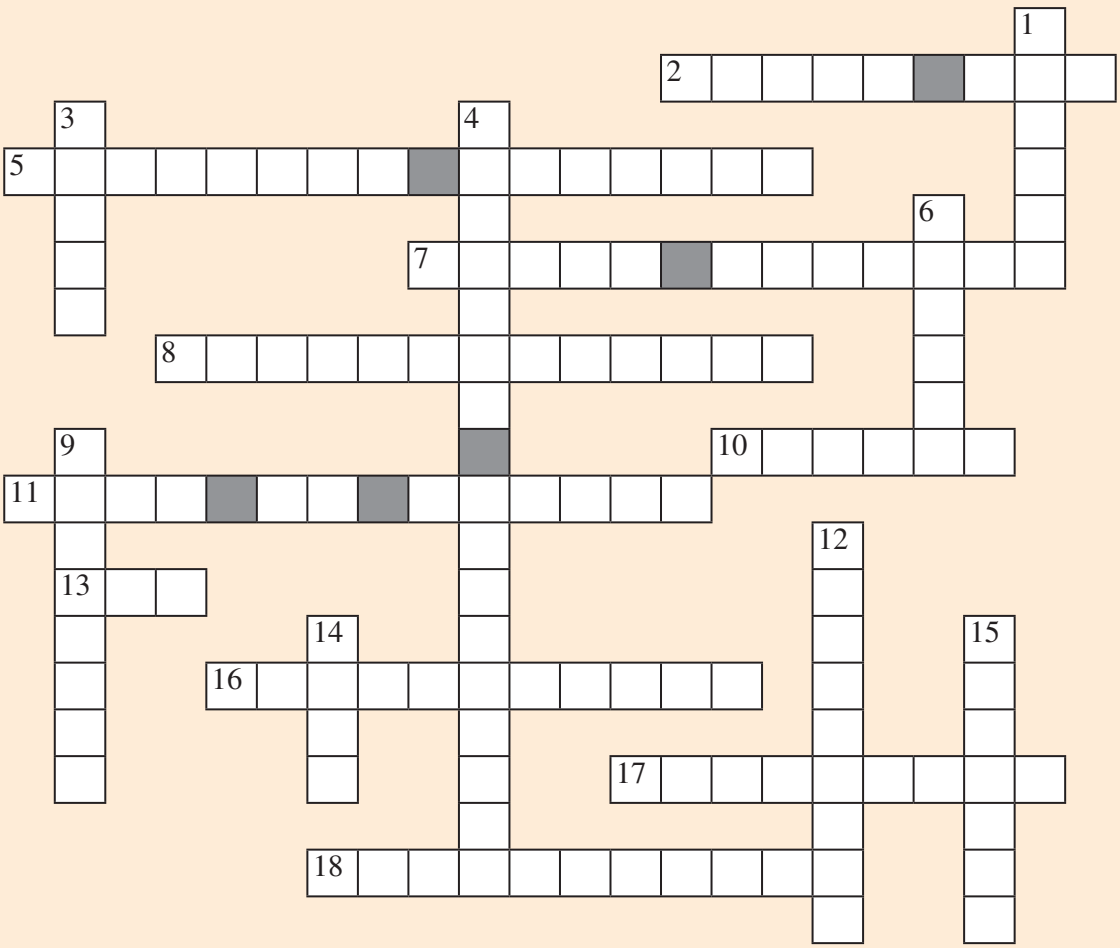
Puzzle



Across

2 Number of weeks in a year
5 A cost that can fluctuate, depending on circumstances
7 A cost with a regular set amount
8 A variable expense that is an activity of enjoyment
10 A spending plan for managing money during a given period of time
11 Everyday expenses on needs and wants
13 Number of weeks in a fortnight
16 A variable expense that can be affected by the weather
17 Number of fortnights in a year
18 Money spent on goods and services

Down

1 Number of months per annum
3 A fixed expense paid to the local council
4 A fixed expense that one pays towards possible medical needs
6 Money earned through investments or employment
9 A fixed expense that one pays towards a debt on a house
12 Water, electricity, gas are all _____.
14 A fixed expense that one pays when they do not own the house they live in
15 The amount of money one sets aside to aim for a goal

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Chapter checklist

☐ I can read a utility bill.

1 Refer to Rachel's electricity bill to answer the following questions.

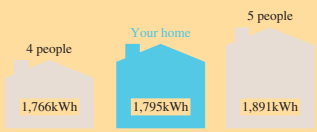
- **a** How long is the time period for Rachel's bill?
- **b** What is the total cost of her bill?
- **c** What is the average daily cost?
- **d** What is the average daily kWh usage?
- **e** Has the amount of electricity used increased or decreased over the course of the year?
- **f** Based on the comparison with other people's homes in Rachel's area, how many people would you estimate live in in her home?

Company Name: ABC Electrical
Customer Name/address: Rachel Brightwater
17 Tintaldra Court
Murgon Qld 4605

How much energy are you using?

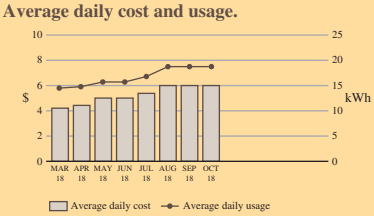
Bill period: 20 Jul 2018 to 23 Oct 2018 (96 days)

Compare with other homes in your area.



Average usage data supplied by Australian Energy Regulator based on homes with average gas usage and no pool during spring. Visit energymadeeasy.gov.au for more information.

Average daily cost and usage.



Snapshot.
Average daily cost: **$6.44**
Average daily usage: **18.70kWh**

Tax Invoice Issued 26 Oct 2018

Your bill overview.

Balance brought forward	$0.00
+	
New charges	$618.24
=	
Total due	$618.24
Discounted amount if paid by due date	$604.82
Due date	15 Nov 2018

To avoid a late payment fee of $13.42. please pay by the due date.

Thank you.

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☐ I can convert between weekly, fortnightly, monthly and yearly costs.

2 Convert the following expenses to the period indicated in the brackets.

- **a** Rent $415 per week (month)
- **b** Mobile phone plan $89 per month (week)
- **c** Private health insurance $117 per month (year)
- **d** Rates $690 for 6 months (week)
- **e** Internet plan $60 per month (fortnight)
- **f** Car insurance $177 per quarter (year)
- **g** Car registration $420 for 6 months (fortnight)
- **h** Mortgage repayments $912.50 per fortnight (year)

☐ I can identify the fixed and variable expenses involved when living independently.

☐ I can list five fixed expenses and five variable expenses.

☐ I can calculate monthly savings and how to create a personal budget.

3 Alex's net income is $51 200 p.a. The following list shows his expenses.

Living expenses:

Mortgage $1800 per month
Car loan $52 per week
Electricity bills $22 per week
Rates $860 per 6 months
Petrol $60 per week
Charity donations $48 per month
Mobile phone and internet bundle $79 per month
Private health insurance $122 per month
House and contents insurance $97 per month
Entertainment $100 per week
Food $110 per week
Water bills $15 per week
Car registration $670 per year
Clothes $80 per month

- **a** Calculate Alex's total expenses per month.
- **b** Calculate how much Alex could possibly save per month.
- **c** Create an annual budget for Alex.

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Chapter review

All questions in the Chapter Review are assessment-style.

Complex Familiar

Section 9A

1 Refer to Isabella's council rates notice to answer these questions.

a How long is the time period for Isabella's rates notice?

b If paid by the due date, what is the total amount for this rates notice?

c What is the council's valuation of the land?

d What services do the rates and charges that are paid contribute towards?

Customer Name/address: Isabella Roberts
3 Townsend Street
Buderim Qld 4556

CUSTOMER ENQUIRIES
Phone: (07) 5475 7542
Email: rates@sunshinecoast.qld.gov.au
Fax: (07) 5441 8338
ABN 37 876 973 913

HALF YEARLY RATE NOTICE FOR PERIOD	
1 July 2019 to 31 December 2019	
ISSUE DATE	21 July 2019
PROPERTY NO.	
VALUATION	$ 179,800
REFERENCE	98587214
DUE DATE FOR PAYMENT	**21 August 2019**
NET AMOUNT PAYABLE	**$772.55**

RATES AND CHARGES	UNITS	RATE CHARGED		AMOUNT
Opening Balance				58.36-
General Rate – Category 6		Minimum Rate =		555.00
Waste Bin – 240 Litre	1 ×	$298.80	× .5 =	149.40
Heritage Levy	1 ×	$5.00	× .5 =	2.50
Environment Levy	1 ×	$70.00	× .5 =	35.00
Transport Levy	1 ×	$25.00	× .5 =	12.50
State Emergency Management Levy: Class A Group 2	1 ×	$217.40	× .5 =	108.70
Total:				**$804.74**
Discount - (only if paid by 21 August 2019):				$32.19
Net amount Payable:				**$772.55**

Section 9B

2 Identify the following as either a fixed (F) expense or a variable (V) expense.

a Petrol
b Electricity bills
c Private health insurance
d Water bill
e Rent
f Mortgage repayments
g House insurance
h Clothing
i Gifts
j Phone plan
k Personal loan repayments
l Public transport
m Car registration
n Going to the movies
o Food
p Shoes
q Coffee at a café
r Rugby union tickets
s Council rates
t Car insurance
u Going out to brunch with friends

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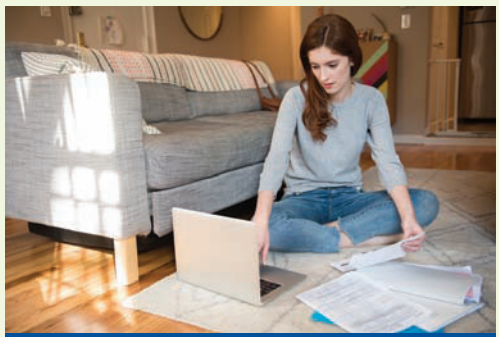
Section 9C

3 Charlie has calculated that she spends $855 per week on living expenses. She has just accepted a new job offer that pays a net income of $1780 per fortnight.

a Calculate whether this new income will be enough to cover Charlie's expenditure.

b If Charlie must now use public transport to travel to and from her new job, costing $27 per week, will she also be able to afford to buy lunch at $12 per day on her new income?



Charlie recalculates her budget after accepting a new job offer.

COMPLEX UNFAMILIAR

Section 9A

4 Refer to Review Question **1** to answer this question.
In order to pay her council rates bill, calculate how much Isabella would need to allow in her budget per:

a year

b fortnight

c month

Section 9B

5 Aedan's weekly expenses are given. Use the information to complete the following.

a Calculate the cost of Aedan's weekly fixed expenses.

b Calculate the cost of Aedan's weekly variable expenses.

c Should Aedan decide to start saving some money each week, suggest some expenses that he could reduce.

Expenses
Rent $320
Electricity bills $80
Mobile phone plan $20
Health insurance $35
House and contents insurance $18
Car registration $21
Car insurance $17
Petrol $60
Food $150
Clothing $20
Entertainment $100
Water bills $12
Total: $853

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Section 9C

6 Lucas is a painter who owns a house and a car. He works full-time, and his net income is $1090 per week. His expenses include:

$1980 per month for the mortgage
$120 per week for groceries and take-away
$100 per week on entertainment
$65 per week for petrol
$170 per month for utilities
$69 per month for his phone plan
$200 every 3 months on clothes
$2000 once a year for a holiday

Calculate whether Lucas earns enough money per fortnight to cover his living expenses.

7 Zamira is trying to save $1800 for a new TV. She earns a net income of $40 530 p.a. Using the following expenditure information, create a weekly budget for Zamira and calculate the number of fortnights that she will need to save, to achieve her goal.

Living expenses:

Mortgage $320 per week
Pet insurance $7.50 per week
Electricity bills $24 per week
Mobile phone plan $49 per month
Internet $10 per week
Private health insurance $23 per week
Contents insurance $58 per month
Entertainment $60 per week
Food $130 per week
Water bills $18 per week
Car registration $620 per year
Petrol $70 per week
Clothes $500 per year
Charity donations $200 per year

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10 Time

Maths for a disability case manager: Ashley Rohan

Ashley Rohan was raised on a farm and pursued a career as a stock agent, selling livestock in rural South Australia for 10 years, before changing industries to pursue his dream of working in the health sector. He is now employed as a disability case manager in Queensland and he works with individuals to help them achieve their goals and improve their lives.

Tell us a bit about your job. What does a typical day look like?

As a disability case manager, I work with individuals who have a disability. I help them with personal goals such as finding hobbies and even attending courses such as barista training. I also help them with everyday things such as grocery shopping and going to the beach. I enjoy helping people and bringing joy to their lives.

What maths did you study at school?

I studied Business Maths in school. It was not a favourite subject of mine and I did struggle to understand a lot of it but now, upon reflection, I realise how important it is in everyday life. So I'm certainly glad that I persevered and applied myself to complete the subject.

How do you use maths in your job?

I use maths on a daily basis in my career. I help individuals to work on personal budgets. Plus I administer medications and need to calculate dosage rates. I create meal plans for individuals and help them to set fitness goals, which requires percentage calculations. I also use maths when reading timetables and calculating daily trips, as the new Disability Scheme that has been recently implemented requires a lot more use of public transport.

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In this chapter

10A Units of time and representing time

10B Calculating time intervals

10C Interpreting timetables and finding the best route

10D Comparing travel times with various modes of transport

10E Interpreting complex timetables **[complex]**

Problem-solving and modelling task

Puzzle

Chapter Checklist

Chapter Review

Syllabus reference

Unit 2 Topic 2 Time and motion

Time (7 hours)

In this subtopic, students will:

- use units of time and convert between fractional, decimal and digital representations
- represent time using 12-hour and 24-hour clocks
- calculate time intervals, including time between, time ahead, time behind
- interpret timetables for buses, trains and/or ferries
- use several timetables and/or electronic technologies to plan the most time-efficient routes
- interpret complex timetables such as tide charts, sunrise charts and moon phases **[complex]**
- compare the time taken to travel a specific distance with various modes of transport.

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Pre-test

1 Express the following statements as 12-hour times. You are not required to specify p.m. or a.m., so, for example, 'nine' would be '9:00 hours'.

a twelve **b** three seventeen **c** half past seven
d quarter to five **e** quarter past nine **f** five to eleven

2 Convert the following to seconds.

a 2 minutes **b** half an hour **c** 2 hours

3 Convert the following to hours.

a half a day **b** three and a half days **c** 2 weeks

4 Write the following times in words. (You are not required to specify p.m. or a.m.)

a 9:00 **b** 4:30 **c** 11:45
d 8:15 **e** 12:12 **f** 6:49

5 Calculate what was the original time half an hour ago if the time is currently:

a 9:45 a.m. **b** 6 p.m. **c** 12:15 a.m.

6 If it is 4:45 p.m. now, state what the time will be in:

a half an hour **b** 2 hours **c** 12 hours

7 Calculate what time it will be in 2 hours and 45 minutes if the time is currently:

a 5:15 a.m. **b** 6:45 p.m. **c** 10:55 a.m.

A link to a HOTmaths lesson is provided in the Interactive Textbook to revise this topic.

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10A Units of time and representing time

LEARNING GOALS

- Convert between the units of time
- Understand spoken language phrases that state the time
- Convert a time in digital format to time written with the:
  - minutes expressed as a fraction of an hour
  - minutes and seconds expressed as a decimal number
- Convert from time written as a decimal to the digital format of hours : minutes : seconds
- Convert between 12-hour clock time and 24-hour clock time
- Apply time conversions in real-life situations

Why is it essential to understand the various ways that time is written?

Universal formats for writing the time enable worldwide communication which is vital in complex global organisations and when travelling across different time zones.

Time coded into computer language enables humans to communicate with machines, computers and robots; for example, when managing driverless mining trucks and trains.

There are countless applications requiring time measurements and calculations, such as calculating wages and charges; communicating appointment times, and starting and finishing times; understanding transport schedules, and school and university timetables; and computer calculations.

RUN BETWEEN
ออก
DEP.
ปลายทาง
TERMINALES
หมายเหตุ
Bangkok Yala 20.07 11.20 ร.RAP
Bangkok Trang 21.07 08.05 ด.EXP
Bangkok Na Khon Si Thamarat 21.51 09.55 ร.RAP
Bangkok Kantang 22.31 11.20 ร.RAP
Thon Buri Lang Suan 22.59 05.05 ร.RAP
Bangkok Na Khon Si Thamarat 23.33 10.55 ด.EXP
Bangkok Surat Thani 02.20 08.05 ดพ.SP.EXP
Bangkok Yala 02.20 14.30 ดพ.SP.EXP

International travel requires time calculations using 24-hour, 12-hour and both digital and analogue formats.

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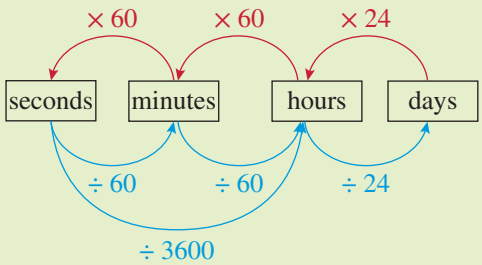
WHAT YOU NEED TO KNOW

- Conversion of **time units**



- Spoken time uses either fractions of an hour or minutes past or before the hour.
  - For example: 5:30 is spoken as 'half past five' or 'five thirty'.
    9:20 is spoken as 'twenty minutes past 9' or 'nine twenty'.
    11:45 is spoken as 'a quarter to twelve' or 'eleven forty-five'.
    We do not say 'eleven and three-quarters'.
    2:15 $= 2\frac{1}{4}$ is spoken as 'a quarter past two' or 'two fifteen'.
- Time in **digital format** is expressed as **hours : minutes : seconds**.
- When converting minutes to a fraction of an hour, divide the minutes by 60 and simplify the fraction.
  - For example: 3:15 = 3 hours and 15 minutes
    $= 3$ hours and $\frac{15}{60}$ hours $\quad \frac{\text{minutes}}{60} = \text{hours}$
    $= 3\frac{1}{4}$ hours
- Converting minutes and seconds to decimal hours
  Either method 1 or 2 can be used.
  - **Method 1:** Convert seconds to minutes, then convert the total minutes to hours.
    For example: 2:23:10.5 = 2 hours 23 minutes and 10.5 seconds
    $= 2 \text{ h} + \left(23 + \frac{10.5}{60}\right) \text{ min}$ $\quad$ seconds ÷ 60 = minutes
    $= 2 \text{ h} + 23.175 \text{ min}$
    $= 2 \text{ h} + \frac{23.175}{60} \text{ h}$ $\quad$ minutes ÷ 60 = hours
    $= 2.38625 \text{ h}$
    $= 2.39 \text{ h}$
  - **Method 2:** Convert minutes to seconds (×60) and add on the number of seconds. Then divide the total number of seconds by 3600 to give decimal hours.

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For example: 4:35:20 = 4 hours 35 minutes and 20 seconds

$= 4 \text{ h} + (35 \times 60 + 20) \text{ s}$

$= 4 \text{ h} + 2120 \text{ s}$

$= 4 \text{ h} + \frac{2120}{3600} \text{ h}$ seconds ÷ 3600 = hours

$= 4.589 \text{ h}$

- Converting time given in decimal form to time in digital format.
  First multiply the decimal part of the hours by 60 to give minutes in decimal form.
  Then multiply the decimal part of the minutes by 60 to give seconds in decimal form, and round to the nearest second.
  - For example: 5.378 = 5 hours + 0.378 hours

$= 5 \text{ h} + 0.378 \times 60 \text{ min}$ hours × 60 = minutes

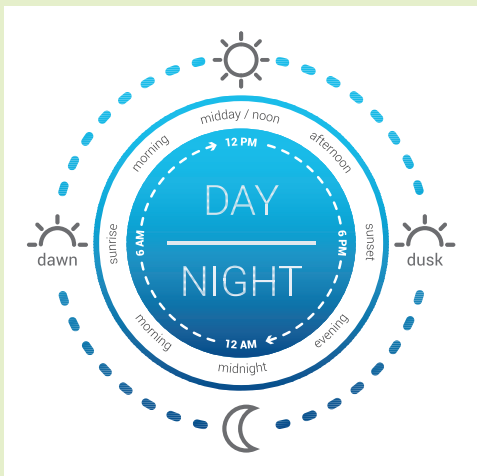
$= 5 \text{ h} + 22.68 \text{ min}$

$= 5 \text{ h} + 22 \text{ min} + 0.68 \times 60 \text{ s}$ minutes × 60 = seconds

$= 5 \text{ h} + 22 \text{ min} + 40.8 \text{ s}$

$= 5 \text{ h:22 min:41 s}$

- Clocks and timepieces can display the time in two different ways.
  - **24-hour clock** time is presented as how many hours and minutes since midnight.
  - **12-hour clock** time is presented by splitting the day into two 12-hour parts: a.m. and p.m.
  - **a.m.** is from midnight to midday and **p.m.** is from midday to midnight.
    For example:



12-hour clock	24-hour clock
12 a.m. (midnight)	00:00
9:45 a.m.	9:45
12 p.m. (midday)	12:00
2:30 p.m.	14:30

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Example 1 Convert time in digital format to time with the minutes expressed as a fraction of an hour

For each of the following times given in digital format:

i Write the minutes as a fraction of an hour and use division to simplify.

ii Write how each fractional time is spoken.

a 4:15 p.m. **b** 8:30 a.m. **c** 12:45 p.m.

WORKING	THINKING
a i 4:15 p.m. $= 4\frac{15}{60}$ h $= 4\frac{1}{4}$ p.m.	4:15 p.m. = 4 h and 15 min Work out 15 min out of 60 min: HCF = 15, so $\frac{15}{60} = \frac{1}{4}$.
ii a quarter past four	
b i 8:30 a.m. $= 8\frac{30}{60}$ h $= 8\frac{1}{2}$ p.m.	8:30 p.m. = 8 h and 30 min Work out 30 min out of 60 min: HCF = 30, so $\frac{30}{60} = \frac{1}{2}$.
ii half past eight	
c i 12:45 p.m. $= 12\frac{45}{60}$ h $= 12\frac{3}{4}$ p.m.	12:45 p.m. = 12 h and 45 min Work out 45 min out of 60 min: HCF = 15, so $\frac{45}{60} = \frac{3}{4}$.
ii a quarter to one	As there is only $\frac{1}{4}$ of an hour before 1 p.m., this time is spoken as 'a quarter to one'.

Example 2 Convert time in digital format to time with the minutes and seconds expressed as a decimal

Express the following times given in digital format to times with the minutes and seconds calculated as a decimal, rounding to two decimal places.

a 7:35 **b** 2:43 **c** 8:15:48 **d** 5:33:27

WORKING	THINKING
a 7:35 $= 7 + \frac{35}{60}$ $= 7.58$ h	7 h is the whole number. 35 ÷ 60 = 0.58333 h Round your answer to two decimal places.

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b $2{:}43 = 2 + \frac{43}{60}$
$= 2.72 \text{ h}$

2 h is the whole number.
43 ÷ 60 = 0.7167 h
Round your answer to two decimal places.

c $8{:}15{:}48 = 8 \text{ h} + \left(15 + \frac{48}{60}\right) \text{ min}$
$= 8 \text{ h} + 15.8 \text{ min}$
$= 8 \text{ h} + \frac{15.8}{60} \text{ h}$
$= 8.26 \text{ h}$

8 is the whole number of hours.
48 seconds ÷ 60 = 0.8 min
15.8 minutes ÷ 60 = 0.263 h
Round your answer to 0.26 h.
The time in decimal format is 8.26 h.

d $5{:}33{:}27 = 5 \text{ h} + (33 \times 60 + 27) \text{ s}$
$= 5 \text{ h} + 2007 \text{ s}$
$= 5 \text{ h} + \frac{2007}{3600} \text{ h}$
$= 5.56 \text{ h}$

This solution uses the alternative method of first converting minutes and seconds to total seconds.
5 is the whole number of hours.
33 × 60 = 1980 s
1980 s + 27 s = 2007 s
2007 s ÷ 3600 s = 0.5575 h and rounds to 0.56 h.

Example 3 Convert time written in decimal form to the digital format of hours : minutes : seconds

The following times are written in decimal form. Express these times in the digital format hours : minutes : seconds, using multiplication to express the decimal part as minutes and seconds.

a 9.6 h **b** 11.3 h **c** 12.253 h

WORKING	THINKING
a $9.6 \text{ h} = 9 \text{ h} + (0.6 \times 60) \text{ min}$ $= 9{:}36 \text{ a.m.}$	9 h stays the same. Multiply the decimal place by 60, so 0.6 × 60 = 36 min. Write the solution in the form of hours : minutes. The answer is a.m. because 9 h is less than 12 h in the 24-hour clock.

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b 11.3 a.m. = 11 h + (0.3 × 60) min
= 11:18 a.m.

11 h stays the same.
0.3 × 60 = 18 min
Write the solution in the form of hours : minutes. The answer is a.m. because 11 h is less than 12 h in the 24-hour clock.

c 12.253 p.m. = 12 h + (0.253 × 60) min
= 12 h + 15.18 min
= 12 h + 15 min + (0.18 × 60) s
= 12 h + 15 min + 11 s
= 12:15:11 p.m.

12 h stays the same.
0.253 × 60 = 15.18 = 15 min + 0.18 min
0.18 × 60 = 10.8 s = 11 s
Write the solution in the form of hours : minutes : seconds.
The answer is p.m. because 12 h have passed in 24-hour clock time.

Example 4 Convert from a 12-hour clock to the 24-hour clock

Express these 12-hour digital times as 24-hour times.

a 8:30 a.m. **b** 12:07 a.m. **c** 2:35 p.m. **d** 10:17 p.m.

WORKING	THINKING
a 8:30 a.m. = 08:30	From 1 a.m. to 11:59 a.m., 12-hour and 24-hour time is the same, except single digit hours start with a zero.
b 12:07 a.m. = 00:07	From 12 a.m. to 12:59 a.m. is represented as 00:00 to 00:59 on the 24-hour clock.
c 2:35 p.m. = (2 + 12) h + 35 min = 14:35	Between 1 p.m. and 11:59 p.m. add 12 to the hour, but the minutes remain the same.
d 10:17 p.m. = (10 + 12) h + 17 min = 22:17	Between 1 p.m. and 11:59 p.m. add 12 to the hour, but the minutes remain the same.

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Example 5 Convert from the 24-hour clock to a 12-hour clock

Express the following 24-hour times as 12-hour digital times.

a 00:59 **b** 03:37 **c** 12:15 **d** 16:45 **e** 23:08

WORKING	THINKING
a 00:59 = 12:59 a.m.	00:59 means 59 min after midnight, as 24-hour time measures the time from midnight. It is a.m. time on the 12-hour clock.
b 03:37 = 3:37 a.m.	03:37 means 3 h and 37 min after midnight. It is a.m. time on the 12-hour clock.
c 12:15 = 12:15 p.m.	12:15 means 12 h and 15 min after midnight, so change to p.m. time.
d 16:45 = (16 − 12) h + 45 min = 4:45 p.m.	16:45 means 16 h and 15 min after midnight. Subtract 12 from the number of hours for p.m. time.
e 23:08 = (23 − 12) h + 8 min = 11:08 p.m.	23:08 means 23 h and 59 min after midnight. Subtract 12 from the number of hours for p.m. time.

Example 6 Converting time representations in a real-world situation

Jack is an army recruit and he has received a text message from his Lieutenant General saying to meet for a training session at 17:30 hours. Jack wears a 12-hour digital watch. Determine what the time will be on Jack's watch when he must meet his Lieutenant General.

WORKING	THINKING
17:30 = 5:30 p.m. = (17 − 12):30 Jack must meet with his Lieutenant General at 5:30 p.m.	Between 13:00 and 23:59 subtract 12 from the number of hours for p.m. time. Minutes stay the same.

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Exercise 10A

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in the following statements.

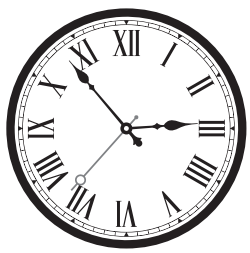
- **a** Time in digital format is expressed as _____:_____:_____.
- **b** To convert minutes to a fraction of an hour, _____ the minutes by ___ and simplify the fraction.
- **c** To convert minutes and seconds to decimal hours:
  - **i** First _____ the number of minutes by ___ and add on the number of _____.
  - **ii** Then divide this total number of seconds by _____ to convert the seconds to decimal hours.
- **d** To convert time given in decimal form to time in digital format.
  - **i** First multiply the decimal part of the hours by ___ to give minutes.
  - **ii** Then multiply the decimal part of the minutes by ___ to give seconds.
- **e** 24-hour clock time is presented as hours and minutes since _____.

2 Identify the time shown on the following analogue clocks and write this in the 12-hour digital time format hours : minutes : seconds.

a

b

c



Example 1

3 For each of the following times given in digital format:

- **i** Write the minutes as a fraction of an hour and use division to simplify.
- **ii** Write how each fractional time is spoken.

Hint: Convert the minutes to a fraction out of 60 and simplify.

a 5:15 a.m. **b** 7:20 p.m. **c** 12:30 a.m.
d 10:45 p.m. **e** 6:30 p.m.

Example 2

4 Express the following times in digital format to times with the minutes and seconds calculated as a decimal, rounding to two decimal places.

a 9:35 a.m. **b** 5:43 p.m.
c 12:18 p.m. **d** 1:55 a.m.
e 3:16:30 a.m. **f** 8:33:27 p.m.
g 11:23:45 a.m. **h** 9:08:12 p.m.

Hint: Convert minutes and seconds to total seconds, then ÷ 3600 for decimal hour.

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Example 3

5 The following times are written in decimal form. Express these times in the digital format hours : minutes : seconds, using multiplication to express the decimal part as minutes and seconds.

a 10.5 h
b 9.7 h
c 5.3 h
d 12.8 h
e 7.1 h
f 1.29 h
g 3.55 h
h 7.38 h
i 11.78 h
j 2.94 h

Hint: Decimal part of hours × 60 = minutes
Decimal part of minutes × 60 = seconds

Example 4

6 Express the following 12-hour digital times as 24-hour times.

a 8:37 a.m.
b 4:48 p.m.
c 12:28 p.m.
d 1:55 a.m.
e 3:16 a.m.
f 8:33 p.m.
g 11:23 a.m.
h 12:08 a.m.

Hint: 24-hour time states time from midnight.

Example 5

7 Express the following 24-hour times as 12-hour digital times.

a 09:35
b 15:33
c 12:49
d 01:55
e 21:25
f 17:16
g 23:23
h 13:45
i 00:12
j 11:50

Hint: 12 a.m. is midnight and 12 p.m. is midday or noon.

APPLICATIONS

SF: 8–15 | CF: – | CU: –

★**8** This past week, Steven worked the following number of hours and minutes. Express the number of hours that he worked each day in decimal form.

a 7 h 30 min
b 4 h 45 min
c 9 h 15 min
d 5 h 20 min
e 6 h 40 min
f 7 h 25 min

★**9** Using your answers from Question **8**, calculate the total number of hours that Steven worked that week.

★**10** The following times were collected from a school's cross-country event. They are written in the form of hours : minutes : seconds. Express these times in decimal form, rounding to two decimal places where necessary.

a 1:02:30
b 1:12:48
c 1:20:55
d 1:17:27
e 1:13:08
f 1:01:58

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★11 **a** Consider the two runners from Question **10** who finished with the times 1:02:30 and 1:01:58. Explain which runner is the faster of the two.

b Using the decimal times you calculated in Question **10**, organise them in order from the fastest runner to the slowest runner.

★12 Quinn has received a payslip from her boss showing that she worked for 40.8 hours this past week. Determine how many hours and minutes this represents.

Example 6 ★13 Sarah works full-time at a local bakery. Her roster is in 24-hour time, as shown in the table. Sarah wears a 12-hour digital watch. Determine the equivalent 12-hour times for each start and finish time.

Date	Start time	Finish time
Monday 3/3/19	08:30	13:30
Tuesday 4/3/19	08:30	16:30
Thursday 6/3/19	13:00	17:00
Friday 7/3/19	11:00	20:00

★14 Matthew would like to watch the tennis tonight, which starts at 11:45 p.m. He is going to bed early so that he can have a sleep before the game and then still be up early for work the next day. Matthew's clock uses 24-hour time and he wants the alarm to go off at 11:40 p.m.
Express 11:40 p.m. in 24-hour time to determine the time that Matthew should enter into his clock so that he does not miss the tennis.

★15 When Lachlan was mowing the lawn one afternoon, he noticed his watch had stopped at a quarter to eleven. He asked his wife, Belinda, for the time and she replied, "It's twenty to three."

a If the house clock uses 24-hour digital time, what time did Belinda see on the clock?

b Calculate for how long Lachlan's watch had stopped, if it had stopped:

i that morning

ii the previous night

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10B Calculating time intervals

LEARNING GOALS

- Calculate the hours : minutes : seconds between two given times
- Calculate the clock time a certain number of hours ahead or behind a given clock time
- Apply clock time calculations in real-life situations

When is it essential to calculate time intervals?

When working with time schedules, it is important to accurately calculate the length of a time interval, in hours, minutes and seconds, between two clock times.

For a medical emergency, the patient's arrival time at the hospital must be accurately calculated.

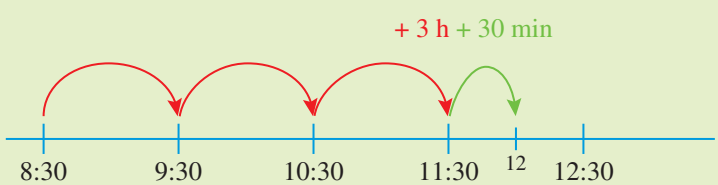
For example, many wage calculations require knowing the exact time worked; the cost of hiring expensive machines (e.g. a helicopter) is based on the exact time of usage; the crucial time for a political meeting or medical procedure will affect earlier events that day; and when travelling we certainly need to know the time interval between connecting flights or train departures.

WHAT YOU NEED TO KNOW

- Basic time measurements

  24 hours per day
  60 minutes in 1 hour
  60 seconds in 1 minute
  Midnight is 12 a.m., the middle of the night.
  Midday or noon is 12 p.m., the middle of the day.

- Calculate time intervals using a timeline
  - For example: The time difference between 8:30 a.m. and 12 p.m. is 3 h and 30 min.



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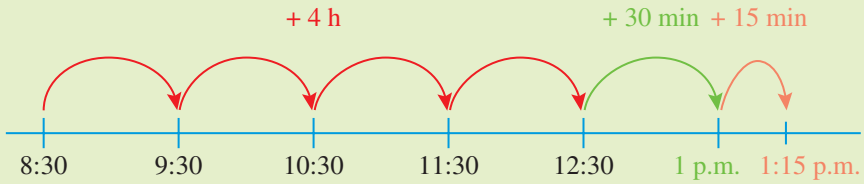
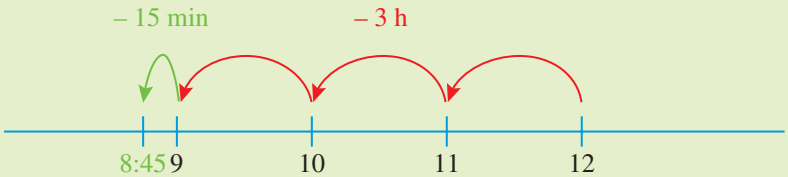
- For example: The time 4 h and 45 min after 8:30 a.m. is 1:15 p.m.



- For example: The time 3 h and 15 min earlier from midday is 8:45 a.m.



Example 7 Calculate the hours : minutes : seconds between two given times

Calculate the length of time between each of these time periods.

a 1:30 p.m. to 7 p.m.

b 12:45 a.m. to 3:30 p.m.

c 8:47 a.m. to 12:08 p.m.

WORKING	THINKING
a 1:30 p.m. to 7 p.m.	1:30 p.m. to 6:30 p.m. = 5 h and then 6:30 p.m. to 7 p.m. = 30 min. Adding both parts together gives 5 h and 30 min.
1.30 p.m. to 6:30 p.m. = 5 h	
6:30 p.m. to 7 p.m. = 30 min	
Time = 5 h 30 min	
b 12:45 a.m. to 3:30 p.m.	Break up the time into parts that are manageable.
12:45 a.m. to 2:45 p.m. = 14 h	15 min + 30 min = 45 min and add the hours back in, giving 14 h and 45 min.
2:45 p.m. to 3:00 p.m. = 15 min	
3:00 p.m. to 3:30 p.m. = 30 min	
Time = 14 h 45 min	
c 8:47 a.m. to 12:08 p.m.	Break up the time into parts that are manageable.
8:47 a.m. to 11:47 a.m. = 3 h	13 min + 8 min = 21 min and add the hours back in, giving 3 h and 21 min.
11:47 a.m. to 12 p.m. = 13 min	
12 p.m. to 12:08 p.m. = 8 min	
Time = 3 h 21 min	

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Example 8 Calculate the number of hours ahead of a given time

Calculate what time it will be in 2 h and 15 min when the current time is:

a 8:30 a.m. **b** 2:17 p.m. **c** 10:47 p.m.

WORKING	THINKING
a 8.30 a.m. + 2 h = 10:30 a.m. 10:30 a.m. + 15 min = 10:45 a.m. Time is 10:45 a.m.	Add the hours and minutes to the current time, in parts. So 8:30 a.m. plus 2 h = 10:30 a.m. Plus 15 min = 10:45 a.m. (Check your calculations by adding together the hours and minutes that you added on, so 2 h + 15 min.)
b 2:17 p.m. + 2 h = 4:17 p.m. 4:17 p.m. + 10 min = 4:27 p.m. 4:27 p.m. + 5 min = 4:32 p.m. Time is 4:32 p.m.	Add the hours and minutes to the current time, in parts. So 2:17 p.m. plus 2 h = 4:17 p.m. plus 10 min = 4:27 p.m. plus 5 min = 4:32 p.m. (Check your calculations by adding together the hours and minutes that you added on, so 2 h + 10 min + 15 min = 2 h 15 min.)
c 10:47 p.m. + 2 h = 12:47 a.m. 12:47 a.m. + 10 min = 12:57 a.m. 12:57 a.m. + 5 min = 1:02 a.m. Time is 1:02 a.m.	Add the hours and minutes to the current time, in parts. So 10:47 p.m. plus 2 h = 12:47 a.m. (be mindful of the p.m. to a.m. change here) plus 10 min = 12:57 a.m. Plus 5 min = 1:02 a.m. (Check your calculations by adding together the hours and minutes.)

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Example 9 Calculate the number of hours behind a given time

Calculate what was the time 2 h and 41 min ago when the time is currently:

a 12 p.m. **b** 8:43 a.m. **c** 11:35 a.m.

WORKING	THINKING
a 12 p.m. − 2 h = 10 a.m. 10 a.m. − 30 min = 9:30 a.m. 9:30 a.m. − 10 min = 9:20 a.m. 9:20 a.m. − 1 min = 9:19 a.m. Time was 9:19 a.m.	Break up 41 min into 30 min + 10 min + 1 min. Check your calculations by adding together the hours and minutes that you subtracted, so 2 h + 30 min + 10 min + 1 min = 2 h 41 min.
b 8:43 a.m. − 2 h = 6:43 a.m. 6:43 a.m. − 40 min = 6:03 a.m. 6:03 a.m. − 1 min = 6:02 a.m. Time was 6:02 a.m.	Break up 41 min into 40 min + 1 min. Check your work by adding the hours and minutes.
c 11:35 a.m. − 2 h = 9:35 a.m. 9:35 a.m. − 30 min = 9:05 a.m. 9:05 a.m. − 10 min = 8:55 a.m. 8:55 a.m. − 1 min = 8:54 a.m. Time was 8:54 a.m.	Break up 41 min into 30 min + 10 min + 1 min. Check your work by adding the hours and minutes.

Example 10 Applying clock time calculations in a real-life situation

George went to his local shopping centre and parked in a 2.5 h carpark. He arrived at 12:17 p.m. and was back at his car by 2:57 p.m. Determine whether or not George could have a fine for parking too long.

WORKING	THINKING
12:17 p.m. + 2 h = 2:17 p.m. 2:17 p.m. + 30 min = 2:47 p.m. George needed to be back at his car by 2:47 p.m. and was 10 min late. George could have a parking fine.	Calculate the latest time that George would need to leave the carpark to avoid a fine. Add the 2 h and 30 min in parts to his arrival time. George went over the 2.5 h parking limit.

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Exercise 10B

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in the following statements.

- **a** There are __ hours per day.
- **b** There are __ minutes in 1 hour.
- **c** There are __ seconds in 1 minute.
- **d** Midnight is __ a.m., the middle of the _____.
- **e** Twenty minutes to midnight is written as __:__ _._. in 12-hour time.
- **f** Twenty minutes to 1 a.m. is written as __:__ _._. in 12-hour time.
- **g** Midday or noon is 12 _._., the middle of the _____.

Example 7

2 Calculate the length of time, in hours : minutes : seconds, between each of these time periods.

- **a** 10:30 a.m. to 5:10 p.m.
- **b** 11:45 a.m. to 2:30 p.m.
- **c** 10:47 a.m. to 12:08 p.m.
- **d** 8:15 a.m. to 2:40 p.m.

Hint Break the time into manageable parts.

Example 8

3 Calculate what time it will be in 3 h and 20 min when the current time is:

- **a** 9:30 a.m.
- **b** 1:15 a.m.
- **c** 11:17 p.m.
- **d** 3:47 p.m.
- **e** 8:39 p.m.

Hint Add the hours and minutes in manageable parts.

Example 9

4 Calculate what was the time 2 h and 28 min ago when the time is currently:

- **a** 12:30 p.m.
- **b** 9:50 a.m.
- **c** 12:35 a.m.
- **d** 7:40 p.m.
- **e** 2:25 a.m.

Hint Subtract the hours and minutes in manageable parts.

5 Calculate the missing times to complete the table.

Start time	End time	Time elapsed (in h and min)
8:40 a.m.	12:25 p.m.	**a**
b	4:50 p.m.	2 h 25 min
11:25 a.m.	**c**	5 h 22 min
1:08 p.m.	11:54 p.m.	**d**
2:34 a.m.	**e**	9 h 44 min
f	6:12 p.m.	7 h 15 min
10:36 a.m.	5:18 p.m.	**g**

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APPLICATIONS

SF: 6–18	CF: –	CU: –

★6 The image displays the simultaneous time in various world cities. Calculate the time difference, in hours, between these cities.

a Hong Kong (clock shows a.m. time) and Sydney (clock shows p.m. time on the same day).

b Moscow (clock shows a.m. time) and Sydney (clock shows p.m. time on the same day).

c Sydney (clock shows p.m. time) and New York (clock shows p.m. time on the previous day).

d Sydney (clock shows p.m. time) and London (clock shows a.m. time on the same day).

Example 10 ★7 Jan went to her local shopping centre and parked in a carpark with a 2.5 h limit. She arrived at 10:57 a.m. and was back at her car by 1:42 p.m. Determine whether or not Jan could have a fine for parking too long.

★8 Peter and his family are off on a camping holiday. It is currently 7:10 a.m. and the GPS is estimating that their destination arrival time is approximately 11:37 a.m. Calculate how long Peter will be driving.

★9 Mahalia is rostered to work from 8:15 a.m. to 3:30 p.m. Calculate the length of her shift, in hours and minutes.

★10 Ella and Madi went to see a movie that started at 4:05 p.m. They called their parents to pick them up as soon as they left the cinema at 6:18 p.m. Determine how long they were at the cinema, in hours and minutes.

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★11 Billy left his car at 6:17 a.m. and hiked the Bartle Frere trail in the rainforest of Wooroonooran National Park, north Queensland. If he arrived back to his car at 5:09 p.m., for how long did Billy hike?

Mount Bartle Frere is Queensland's highest mountain. Hikers should be aware of clock time and walking speed to check their map location.

★12 Hayden's work roster is shown. Calculate the total number of hours he worked that week.

Date	Start time	Finish time
Monday 3/5/19	8:30 a.m.	1:30 p.m.
Tuesday 4/5/19	9:30 a.m.	2 p.m.
Thursday 6/5/19	1 p.m.	5:30 p.m.
Saturday 8/5/19	11 a.m.	6 p.m.

★13 Charlie is off on a holiday to the town of 1770, Queensland. She knows that the trip will take 4.5 hours and she plans to leave at 8:15 a.m. At what time would Charlie expect to arrive at 1770?

★14 Jason is booked in for an MRI on his shoulder. He is told that the scan will take around 55 min. He looks at the time on his way into the room and it is 2:24 p.m. At what time would Jason expect to have completed his MRI?

★15 Doug and Dena are planning to see a movie that starts at 9:15 a.m. and runs for 1 h and 50 min. They have an appointment at 11:10 a.m. next door to the cinemas. Determine whether they could see the movie and still make the appointment on time.

★16 Alana climbed Mount Coolum and when she reached the top at 8:22 a.m., she checked her smartwatch and noticed that she had been climbing for 47 min. At what time did Alana begin her climb?

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★17 Bethany is at the hair salon, having some foils put in her hair. The hairdresser says the foils will take 45 min. The hairdresser begins to wash the foils out of Bethany's hair at 12:08 p.m. At what time did the hairdresser finish applying the foils?

★18 Dean is a truck driver and his workplace insists that he stops for a break after approximately 3 h of driving. At 10:08 a.m., after 3 h and 15 min of continuous driving, Dean finds a nice spot to stop for his morning tea, his first break of the day. At what time did Dean begin driving that day?

PROBLEM-SOLVING

★19 Lynn is catching a flight from South Australia to Queensland. Her flight is meant to depart Adelaide airport at 9:20 a.m., South Australian time, and to arrive at 12:05 p.m. Queensland time, where she is being picked up by her son.

Upon arrival at Adelaide airport, Lynn messages her son that her plane has been delayed and she will now be departing Adelaide at 10:50 a.m., South Australian time. South Australian time is 30 min behind Queensland time.

a Determine the time in Adelaide when the flight was originally expected to arrive in Queensland.

b Determine the actual length of the flight, taking the time difference between States into account.

c For how long was the flight delayed in Adelaide?

d Determine the Queensland time at which the delayed flight is now expected to land. Assume the length of time the flight takes has not been changed by the delayed departure.

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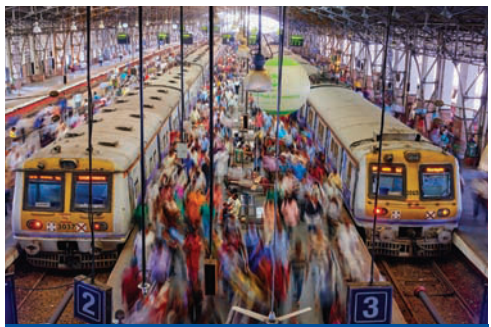
10C Interpreting timetables and finding the best route

LEARNING GOALS

- Read and interpret train, bus and ferry timetables
- Select the best leaving times and routes for public transport
- Select the best route from multiple timetable options

When are timetables essential?

Timetables are essential for communicating the times of multiple future events. We can efficiently meet up in groups using timetables, such as for school classes, work rosters, sporting events, appointments and medical procedures.



Reading public transport timetables is a valuable skill, especially when travelling in India where, on average, over 22 million people travel by train every day.

Timetables or schedules are especially important for public transport, as it communicates between the public and the drivers, the future arrivals and departures of cars, buses, ferries, trams, trains or planes. Such communication is essential for a smoothly run transportation service.

WHAT YOU NEED TO KNOW

- **Public transport timetables** display information like that in the following table.
  Reading down, the *first column* is the list of location names of all the bus stops or train stations.
  Reading across, the *row* for a location shows all the departure times from that location.
  Reading down each *column* listed under each route number, are the departure times from each stop on the route. Each of these columns is a service.
  A timetable may use a single point instead of a colon between the hours and minutes, like the one following (but the time is not decimal time).
  For example, 11.30 a.m. = 11:30 a.m. = half past eleven.

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Route 123

Griffith University to Garden City

servicing Griffith University Nathan Campus, QEII Hospital, Coopers Plains, Sunnybank, Macgregor and Garden City

Monday to Friday

map ref	Route number	123	123	123	123	123	123	123	123	123	123	123	123	123
		am	am	am	am	am	am	pm	pm	pm	pm	pm	pm	pm
A	Griffith University Nathan Campus B	6.50	7.30	8.30	9.00	10.00	11.00	12.00	1.00	2.00	3.00	4.00	5.00	6.00
B	Coopers Plains	6.58	7.40	8.40	9.10	10.09	11.09	12.09	1.09	2.09	3.09	4.09	5.09	6.09
C	Sunnybank Hills stop 70	7.09	7.52	8.50	9.20	10.19	11.19	12.19	1.19	2.19	3.19	4.19	5.19	6.19
D	Altandi	7.13	7.58	8.56	9.26	10.25	11.25	12.25	1.25	2.25	3.25	4.25	5.25	6.25
E	Sunnybank K-Mart	7.17	8.02	9.00	9.30	10.29	11.29	12.29	1.29	2.29	3.29	4.29	5.29	6.29
F	Garden City Interchange	7.42	8.28	9.22	9.52	10.50	11.50	12.50	1.50	2.50	3.50	4.50	5.50	6.50

Image provided courtesy of TransLink, Department of Transport and Main Roads (Effective, August 2018).

Route 123

Griffith University to Garden City

servicing Griffith University Nathan Campus, QEII Hospital, Coopers Plains, Sunnybank, Macgregor and Garden City

Monday to Friday

map ref	Route number	123	123	123	123	123	123	123	123	123	123	123	123	123
		am	am	am	am	am	am	pm	pm	pm	pm	pm	pm	pm
A	Griffith University Nathan Campus B	6.50	7.30	8.30	9.00	10.00	11.00	12.00	1.00	2.00	3.00	4.00	5.00	6.00
B	Coopers Plains	6.58	7.40	8.40	9.10	10.09	11.09	12.09	1.09	2.09	3.09	4.09	5.09	6.09
C	Sunnybank Hills stop 70	7.09	7.52	8.50	9.20	10.19	11.19	12.19	1.19	2.19	3.19	4.19	5.19	6.19
D	Altandi	7.13	7.58	8.56	9.26	10.25	11.25	12.25	1.25	2.25	3.25	4.25	5.25	6.25
E	Sunnybank K-Mart	7.17	8.02	9.00	9.30	10.29	11.29	12.29	1.29	2.29	3.29	4.29	5.29	6.29
F	Garden City Interchange	7.42	8.28	9.22	9.52	10.50	11.50	12.50	1.50	2.50	3.50	4.50	5.50	6.50

Image provided courtesy of TransLink, Department of Transport and Main Roads (Effective, August 2018).

Reading the given table *across* from Altandi, we see that, on weekdays, the bus for route 123 departs from Altandi at 7:13 a.m., 7:58 a.m., 8:56 a.m., 9:26 a.m., etc.

Reading *down* the second column, we see that the first bus for route number 123 departs from Griffith Uni at 6:50 a.m. and is expected to arrive at Coopers Plains at 6:58 a.m., Sunnybank Hills at 7:09 a.m., Altandi at 7:13 a.m., etc.

- How to read timetables when choosing the start and finish locations:
  1. Select your departure location and go across to the time when you choose to depart.
  2. Run your finger down the column until you reach the desired finish location and read the arrival time.
     - For example, bus route number 123 departs Griffith University at 8:30 a.m. and arrives at the Sunnybank K-Mart shops at 9:00 a.m.

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Example 11 Reading and interpreting a train timetable

This train timetable shows the schedule from the Train Terminal to the Botanical Gardens. Use the timetable information to answer the following.

Train route 178 ➔ Terminal to the Botanical Gardens: Monday–Friday						
Station	**a.m.**	**a.m.**	**p.m.**	**p.m.**	**p.m.**	**p.m.**
Train Terminal	9:06	10:37	12:04	2:06	5:06	7:04
Sports Centre	9:19	10:50	12:17	2:19	5:19	7:17
Shopping Centre	9:25	10:56	12:23	2:25	5:25	–
University Campus	9:44	11:15	12:42	2:44	5:44	7:38
Botanical Gardens	9:48	11:19	12:46	2:48	5:48	7:42

a Determine how many times each day a train for route 178 departs the Train Terminal.
b Determine how many stops this train makes en route to the Botanical Gardens.
c Identify which departing train does not make all the stops. What might be a reasonable explanation for this?
d Determine how long it takes for the train to get from the Terminal to the Botanical Gardens.
e Paul catches the 10:37 a.m. train from the Terminal. At what time would he expect to arrive at the Botanical Gardens?
f Stacey catches the 5:19 p.m. train from the Sports Centre. At what time would she expect to arrive at the University Campus?

WORKING	THINKING
a There are six trains along this route each day departing from the Terminal.	Count the number of departure times in the row across from the Terminal station.
b five stops	Count the number of stations.
c The 7:04 p.m. train does not stop at the Shopping Centre, perhaps because the Centre is closed at this time.	Note the dash (–) on the 7:04 p.m. train at the Shopping Centre station.
d 9:06 to 9:48 (or 10:37 to 11:19, etc.) 9:06 to 9:46 = 40 min 9:46 to 9:48 = 2 min 40 + 2 = 42 min	Calculate the time interval, in parts, from the departure time to the arrival time.
e 11:19 a.m.	Read off the departure and arrival times on the timetable.
f 5:44 p.m.	Read off the departure and arrival times on the timetable.

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Example 12 Selecting the best leaving times and bus routes

Josh lives at Eight Mile Plains and works Mondays to Fridays in South Bank, starting work at 8 a.m.
He catches a bus from Eight Mile Plains station to South Bank Busway station and then walks for 5 min to his workplace.
Use the Brisbane 111 bus timetable shown to answer the following questions.

Monday to Friday (cont...)

map ref	Route number	160	111	111	160	111	111	160	111	111	111	160	111	111	160	111	160	111	111	160	111	111
		am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am
A	Eight Mile Plains station PL1	-	7.25	7.30	-	7.35	7.40	-	7.45	7.50	7.55	-	8.00	8.05	-	8.10	-	8.15	8.20	-	8.25	8.30
B	Garden City Depot stop	7.25	-	-	7.35	-	-	7.45	-	-	-	7.55	-	-	8.05	-	8.15	-	-	8.25	-	-
C	Upper Mount Gravatt station PL1	7.28	7.28	7.33	7.38	7.38	7.43	7.48	7.48	7.53	7.58	7.58	8.03	8.08	8.08	8.13	8.18	8.18	8.23	8.28	8.28	8.33
D	Griffith University station PL1	7.31	7.31	7.36	7.41	7.41	7.46	7.51	7.51	7.56	8.01	8.01	8.06	8.11	8.11	8.16	8.21	8.21	8.26	8.31	8.31	8.36
E	Holland Park West station PL1	7.34	7.33	7.38	7.44	7.43	7.48	7.54	7.53	7.58	8.03	8.04	8.08	8.13	8.14	8.18	8.24	8.23	8.28	8.34	8.33	8.38
F	Greenslopes station PL1	7.37	7.36	7.41	7.47	7.46	7.51	7.57	7.56	8.01	8.06	8.07	8.11	8.16	8.17	8.21	8.27	8.26	8.31	8.37	8.36	8.41
G	Buranda Busway station PL1	7.40	7.38	7.43	7.50	7.48	7.53	8.00	7.58	8.03	8.08	8.10	8.13	8.18	8.20	8.23	8.30	8.28	8.33	8.40	8.38	8.43
H	Mater Hill station PL1	7.43	7.40	7.45	7.53	7.50	7.55	8.03	8.00	8.05	8.10	8.13	8.15	8.20	8.23	8.25	8.33	8.30	8.35	8.43	8.40	8.45
I	South Bank Busway station PL1	7.46	7.42	7.47	7.56	7.52	7.57	8.06	8.02	8.07	8.12	8.16	8.17	8.22	8.26	8.27	8.36	8.32	8.37	8.46	8.42	8.47
J	Cultural Centre station PL1	7.51	7.47	7.52	8.01	7.57	8.02	8.11	8.07	8.12	8.17	8.21	8.22	8.27	8.31	8.32	8.41	8.37	8.42	8.51	8.47	8.52
K	City, Queen St station	7.56	-	-	8.06	-	-	8.16	-	-	-	8.26	-	-	8.36	-	8.46	-	-	8.56	-	-
L	King George Square station 1F	-	7.52	7.57	-	8.02	8.07	-	8.12	8.17	8.22	-	8.27	8.32	-	8.37	-	8.42	8.47	-	8.52	8.57
M	Roma St Busway station PL1	-	7.58	8.03	-	8.08	8.13	-	8.18	8.23	8.28	-	8.33	8.38	-	8.43	-	8.48	8.53	-	8.58	9.03

Image provided courtesy of TransLink, Department of Transport and Main Roads (Effective, August 2018).

a Identify two times and their bus routes that Josh could catch to work in the mornings.

b Give a reason for which time and route is better.

WORKING

a Route 1: The 111 bus route at 7:30 a.m.
Route 2: The 111 bus route at 7:35 a.m.

b It would be best for Josh to aim for the 7:30 bus, as that would give him time to get to work and settle in for the day. But if he is running late, he could then catch the 7:35 a.m. bus.

THINKING

Need to check the timetable and make sure that Josh arrives at South Bank no later than 7:55 a.m., as this allows him the 5 min of walking time. It could also be suggested that Josh catches the 7:25 a.m. bus, as long as it is reasonably justified.

Example 13 Selecting the best route from multiple timetable options

Keeley has an interview with a professional surf photography company at Noosa Heads. She lives in Brisbane and must catch a train from Roma Street to Nambour, and then a bus from Nambour to Noosa Heads for her 1.30 p.m. interview.
Use the information in the following timetables to select which train and then which bus Keeley should catch to arrive at her interview on time. Justify your selection of times.

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Train timetable

City to Gympie North
outbound
QueenslandRail

Monday to Thursday

Comes from			RSW	RSW		IPS	IPS	IPS	SFC	IPS		IPS	IPS	IPS	IPS	RDK	IPS	IPS	IPS	IPS
Station	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	pm	pm	pm	pm
Roma Street	4:33	5:03	5:33	6:03	6:33	7:03	7:33	8:03	8:30	9:03	9:29	9:33	10:03	10:33	11:03	11:33	12:03	12:33	1:03	1:33
Central arrive	4:35	5:05	5:35	6:05	6:35	7:05	7:35	8:05	8:32	9:05	9:31	9:35	10:05	10:35	11:05	11:35	12:05	12:35	1:05	1:35
Central depart	4:37	5:07	5:37	6:07	6:37	7:07	7:37	8:07	8:37	9:07	9:33	9:37	10:07	10:37	11:07	11:37	12:07	12:37	1:07	1:37
Fortitude Valley	4:39	5:09	5:39	6:09	6:39	7:09	7:39	8:09	8:39	9:09	9:35	9:39	10:09	10:39	11:09	11:39	12:09	12:39	1:09	1:39
Bowen Hills	4:41	5:11	5:41	6:11	6:41	7:11	7:41	8:11	8:41	9:11	9:37	9:41	10:11	10:41	11:11	11:41	12:11	12:41	1:11	1:41
Runs express from Bowen Hills to Eagle Junction. Refer to inner north timetable servicing the stations in-between.																				
Eagle Junction	4:46	5:16	5:46	6:16	6:46	7:16	7:46	8:16	8:46	9:16	exp	9:46	10:16	10:46	11:16	11:46	12:16	12:46	1:16	1:46
Runs express from Eagle Junction to Northgate. Refer to inner north timetable servicing the stations in-between.																				
Northgate	4:50	5:20	5:50	6:20	6:50	7:20	7:50	8:20	8:50	9:20	9:45	9:50	10:20	10:50	11:20	11:50	12:20	12:50	1:20	1:50
Runs express from Northgate to Petrie. Refer to Redcliffe Peninsula timetable servicing the stations in-between.																				
Petrie	5:06	5:36	6:06	6:36	7:06	7:36	8:06	8:36	9:06	9:36	10:01	10:06	10:36	11:06	11:36	12:06	12:36	1:06	1:36	2:06
Dakabin	5:10	5:40	6:10	6:40	7:10	7:40	8:10	8:40	9:10	9:40	exp	10:10	10:40	11:10	11:40	12:10	12:40	1:10	1:40	2:10
Narangba	5:13	5:43	6:13	6:43	7:13	7:43	8:13	8:43	9:13	9:43	exp	10:13	10:43	11:13	11:43	12:13	12:43	1:13	1:43	2:13
Burpengary	5:18	5:48	6:18	6:48	7:18	7:48	8:18	8:48	9:18	9:48	exp	10:18	10:48	11:18	11:48	12:18	12:48	1:18	1:48	2:18
Morayfield	5:22	5:52	6:22	6:52	7:22	7:52	8:22	8:52	9:22	9:52	exp	10:22	10:52	11:22	11:52	12:22	12:52	1:22	1:52	2:22
Caboolture arrive	5:26	5:56	6:26	6:56	7:26	7:56	8:26	8:56	9:26	9:56	10:19	10:26	10:56	11:26	11:56	12:26	12:56	1:26	1:56	2:26
Change service	----	----	Thru	Bus	----	Thru	Bus	----	Thru	Bus	Thru	----	Thru	Bus	----	Thru	Bus	----	Thru	Bus
Caboolture depart			6:26	7:10		7:56	8:35		9:26	10:11	10:19		10:56	11:30		12:26	1:11		1:56	2:32
Elimbah			6:32	7:20		8:02	8:45		9:32	10:20	10:25		11:02	11:39		12:32	1:20		2:02	2:41
Beerburrum			6:37	7:27		8:07	8:52		9:37	10:27	10:30		11:07	11:46		12:37	1:27		2:07	2:48
Glass House Mtns			6:50	7:35		8:21	9:00		9:45	10:35	10:38		11:15	11:54		12:45	1:35		2:15	2:56
Beerwah			7:04	7:42		8:27	9:07		9:52	10:42	10:44		11:22	12:01		12:52	1:42		2:22	3:03
Australia Zoo			|	7:47		|	9:12		|	10:47	|		12:06	|	|	1:47	|	|	3:08
Landsborough			7:17	7:52		8:36	9:17		9:58	10:53	10:50		11:28	12:12		12:58	1:53		2:28	3:14
Mooloolah			7:34	exp		8:42	exp		10:04	11:05	10:56		11:34	12:24		1:04	2:05		2:34	3:26
Eudlo*			7:40	exp		8:48	exp		10:10	11:14	11:11		11:40	12:33		1:10	2:14		2:40	3:35
Palmwoods			7:52	exp		8:54	exp		10:16	11:21	11:17		11:46	12:40		1:16	2:21		2:47	3:42
Woombye			7:57	exp		8:59	exp		10:21	11:28	11:22		11:51	12:47		1:21	2:28		2:52	3:49
Nambour			8:02	8:20		9:04	9:45		10:26	11:36	11:26		11:56	12:55		1:26	2:36		2:57	3:57
Yandina			----	----		----	----		----	----	11:37		----	----		----	----		----	----
Eumundi											11:45									
Cooroy											11:53									
Pomona											12:01									
Cooran											12:07									
Traveston»											12:13									
Gympie North											12:39									

Image provided courtesy of TransLink, Department of Transport and Main Roads (Effective, August 2018).

Bus timetable

Route 631
Nambour to Noosa via Eumundi and Cooroy
servicing Nambour, Yandina, Eumundi, Cooroy, Tewantin and Noosa Junction

Monday to Friday

map ref	Route number	631	631	631	631	631	631	631	631	631	631	631
		am	am	am	am	pm	pm	pm	pm	pm	pm	pm
T	*For real-time connecting train services, please download the **My TransLink** app, visit **translink.com.au** or call **13 12 30**.*											
E	Nambour station	7.20	9.09	10.33	11.32	12.03	1.33	3.03	4.31	5.31	6.57	7.57
F	Nambour General Hospital	7.23	9.12	10.36	11.35	12.06	1.36	3.06	4.34	5.34	7.00	8.00
G	Yandina	7.32	9.21	10.45	11.44	12.15	1.45	3.15	4.43	5.43	7.09	8.09
D	Eumundi Markets	7.44	9.33	10.57	11.56	12.27	1.57	3.27	4.55	5.55	7.21	8.21
H	Cooroy station	8.01	9.50	11.14	12.13	12.44	2.14	3.44	5.12	6.12	7.38	8.38
I	Tewantin Central	8.17	10.06	11.30	12.29	1.00	2.30	4.00	5.28	6.28	7.54	8.54
B	Noosa Heads station (PL2)	8.29	10.18	11.42	12.41	1.12	2.42	4.12	5.40	6.40	8.06	9.06
A	Noosa Junction station	8.35	10.24	11.48	12.47	1.18	2.48	4.18	5.46	6.46	8.12	9.12

Image provided courtesy of TransLink, Department of Transport and Main Roads (Effective, August 2018).

WORKING

Possible solution:

Train: depart Roma Street 9:29 a.m., arrive 11:26 a.m. Nambour

Bus: depart 11:32 a.m. Nambour, arrive 12:41 p.m. Noosa Heads

or

Bus: depart 12:03 p.m. Nambour, arrive 1:12 p.m. Noosa Heads

If Keeley misses the 11:32 a.m. bus (which is possible given that she will have only 6 min to spare), she can have a back-up plan to catch the 12:03 p.m. bus from Nambour and still arrive at her interview by 1:12 p.m.

THINKING

Multiple solutions are available, including leaving really early to arrive early, which would allow for a surf before the interview. Ensure that the chosen route is reasonable and can be clearly justified.

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Exercise 10C

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in the following statements.

- **a** The first column is the list of _____ names of all the bus _____ or train _____.
- **b** Each row across from a given location lists all the _____ times from that location.
- **c** The column under each route number is a list of the _____ times for each _____ along that _____.

Example 11

2 The train timetable from the Main Terminal to City Parklands is shown. Use this information to answer the following questions.

Train route 121 → Main Terminal to City Parklands: Monday–Friday						
Station	**a.m.**	**a.m.**	**p.m.**	**p.m.**	**p.m.**	**p.m.**
Main Terminal	07:07	09:38	12:05	02:07	05:07	07:05
Stadium	07:19	09:50	12:17	02:19	05:19	07:17
Entertainment Centre	07:26	09:57	12:24	02:26	05:26	–
University Campus	07:44	10:15	12:42	02:44	05:44	07:38
Factory Outlets	07:49	10:20	12:47	02:49	–	–
City Parklands	07:56	10:27	12:54	02:56	05:53	07:50

- **a** Determine how many times each day a train for route 121 departs the Main Terminal.
- **b** Determine how many stops this train makes en route to the City Parklands.
- **c** Identify the departing trains that do not make all the stops.
- **d** Calculate how long it takes for the train to get from the Main Terminal to City Parklands.
- **e** Determine how long it takes the 7:44 a.m. train from University Campus to arrive at City Parklands.
- **f** Kelly catches the 9:38 a.m. train from the Main Terminal. At what time would she arrive at City Parklands?
- **g** Harrison catches the 5:19 p.m. train from the Stadium. At what time would he arrive at the University Campus?

Hint Add or subtract times in manageable parts of a time interval.

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APPLICATIONS

SF: 3–7 | CF: – | CU: –

Example 12 ★3 The Brisbane City Cat ferry timetable is given. Use the timetable to answer the following questions.

Departs Terminal:	am	am	am	am	am	am	am	pm	pm	pm	pm	pm	pm
Northshore Hamilton	10.19	10.34	10.49	11.04	11.19	11.34	11.49	12.04	12.19	12.34	12.49	1.04	1.19
Apollo Road	10.24	10.39	10.54	11.09	11.24	11.39	11.54	12.09	12.24	12.39	12.54	1.09	1.24
Bretts Wharf	10.27	10.42	10.57	11.12	11.27	11.42	11.57	12.12	12.27	12.42	12.57	1.12	1.27
Teneriffe	10.33	10.48	11.03	11.18	11.33	11.48	12.03	12.18	12.33	12.48	1.03	1.18	1.33
Bulimba	10.37	10.52	11.07	11.22	11.37	11.52	12.07	12.22	12.37	12.52	1.07	1.22	1.37
Hawthorne	10.42	10.57	11.12	11.27	11.42	11.57	12.12	12.27	12.42	12.57	1.12	1.27	1.42
New Farm Park	10.47	11.02	11.17	11.32	11.47	12.02	12.17	12.32	12.47	1.02	1.17	1.32	1.47
Mowbray Park	10.51	11.06	11.21	11.36	11.51	12.06	12.21	12.36	12.51	1.06	1.21	1.36	1.51
Sydney Street	10.54	11.09	11.24	11.39	11.54	12.09	12.24	12.39	12.54	1.09	1.24	1.39	1.54
Riverside	11.02	11.17	11.32	11.47	12.02	12.17	12.32	12.47	1.02	1.17	1.32	1.47	2.02
QUT Gardens Point	11.12	11.27	11.42	11.57	12.12	12.27	12.42	12.57	1.12	1.27	1.42	1.57	2.12
South Bank 2	11.16	11.31	11.46	12.01	12.16	12.31	12.46	1.01	1.16	1.31	1.46	2.01	2.16
North Quay	11.20	11.35	11.50	12.05	12.20	12.35	12.50	1.05	1.20	1.35	1.50	2.05	2.20
Milton	11.26	11.41	11.56	12.11	12.26	12.41	12.56	1.11	1.26	1.41	1.56	2.11	2.26
Regatta	11.30	11.45	12.00	12.15	12.30	12.45	1.00	1.15	1.30	1.45	2.00	2.15	2.30
Guyatt Park	11.34	11.49	12.04	12.19	12.34	12.49	1.04	1.19	1.34	1.49	2.04	2.19	2.34
West End	11.37	11.52	12.07	12.22	12.37	12.52	1.07	1.22	1.37	1.52	2.07	2.22	2.37
UQ St Lucia	11.41	11.56	12.11	12.26	12.41	12.56	1.11	1.26	1.41	1.56	2.11	2.26	2.41

Image provided courtesy of TransLink, Department of Transport and Main Roads (Effective, August 2018).

a Saylesh is catching the ferry from Northshore Hamilton to Milton. He hops on the 10:49 a.m. ferry. At what time will he arrive at his destination?

b Graham also arrives at Milton at 11:56 a.m. from the same ferry but he had hopped on at Hawthorne. Identify the time at which he would have caught the ferry.

c Josie has a lecture to attend at QUT every Thursday. The lecture starts at 12 p.m. and she catches the ferry from Bretts Wharf.

i Determine the latest time she could catch the ferry so that she is not late for the lecture.

ii At what time would she expect to arrive at QUT Gardens Point if she catches this ferry?

Hint For parts **c** to **e**, justify (i.e. give reasons for) your final choice of departure time.

d Ashleigh is taking his daughter Ella to the Queensland Museum at South Bank and he has promised she can attend the 1 p.m. insect show. If they are catching the ferry from the Apollo Road terminal, at what time should they catch the ferry, considering that there is a 10 min walk from the South Bank terminal to the Museum and they will still need to purchase tickets for the show when they arrive?

e Tania and Mick have a lunch reservation for 1:30 p.m. at West End. They are catching the ferry from the New Farm Park terminal. What is the latest time they could catch the ferry and get to lunch on time?

A Brisbane ferry with the Storey Bridge in the background.

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★4 The Saturday bus timetable from Cairns Central Spence St to Palm Cove is shown. Use this timetable to answer the following.

route 110/110N 111

Cairns Central Spence St to Palm Cove/Kewarra Beach

servicing Cairns City bus station, Cairns Hospital, Smithfield Shopping Centre, James Cook University and northern beaches

Saturday

Route number	111	110	111	110	111	110	111	110	111	110	111	110	111	110	111	110	111	110	111	110	111	110
	am	am	am	am	am	am	am	am	am	pm	pm	pm	pm	pm	pm	pm	pm	pm	pm	pm	pm	pm
A Cairns Central SC Spence St	7.45	8.15	8.45	9.15	9.45	10.15	10.45	11.15	11.45	12.15	12.45	1.15	1.45	2.15	2.45	3.15	3.45	4.15	4.45	5.15	5.45	6.15
B Cairns City bus station P2	7.50	8.20	8.50	9.20	9.50	10.20	10.50	11.20	11.50	12.20	12.50	1.20	1.50	2.20	2.50	3.20	3.50	4.20	4.50	5.20	5.50	6.19
C Cairns Hospital	7.53	8.23	8.53	9.23	9.53	10.23	10.53	11.23	11.53	12.23	12.53	1.23	1.53	2.23	2.53	3.23	3.53	4.23	4.53	5.23	5.53	6.22
D Sheridan St	8.00	8.30	9.00	9.30	10.00	10.30	11.00	11.30	12.00	12.30	1.00	1.30	2.00	2.30	3.00	3.30	4.00	4.30	5.00	5.30	6.00	6.28
E Smithfield SC	8.13	8.43	9.13	9.43	10.13	10.43	11.13	11.43	12.13	12.43	1.13	1.43	2.13	2.43	3.13	3.43	4.13	4.43	5.13	5.43	6.13	6.38
F James Cook University	8.16	8.46	9.16	9.46	10.16	10.46	11.16	11.46	12.16	12.46	1.16	1.46	2.16	2.46	3.16	3.46	4.16	4.46	5.16	5.46	6.16	6.40
G McGregor Rd	8.20	-	9.20	-	10.20	-	11.20	-	12.20	-	1.20	-	2.20	-	3.20	-	4.20	-	5.20	-	6.20	-
H Reed Rd	8.23	-	9.23	-	10.23	-	11.23	-	12.23	-	1.23	-	2.23	-	3.23	-	4.23	-	5.23	-	6.23	-
I Trinity Beach Rd (Moore St)	8.29	-	9.29	-	10.29	-	11.29	-	12.29	-	1.29	-	2.29	-	3.29	-	4.29	-	5.29	-	6.29	-
J Trinity Beach Rd (CCHwy)	8.34	-	9.34	-	10.34	-	11.34	-	12.34	-	1.34	-	2.34	-	3.34	-	4.34	-	5.34	-	6.34	-
L Captain Cook Hwy	8.38	8.54	9.38	9.54	10.38	10.54	11.38	11.54	12.38	12.54	1.38	1.54	2.38	2.54	3.38	3.54	4.38	4.54	5.38	5.54	6.38	6.48
K Kewarra Beach	8.44	-	9.44	-	10.44	-	11.44	-	12.44	-	1.44	-	2.44	-	3.44	-	4.44	-	5.44	-	6.44	-
M Clifton Rd	-	8.59	-	9.59	-	10.59	-	11.59	-	12.59	-	1.59	-	2.59	-	3.59	-	4.59	-	5.59	-	6.53
N Endeavour Rd	-	9.03	-	10.03	-	11.03	-	12.03	-	1.03	-	2.03	-	3.03	-	4.03	-	5.03	-	6.03	-	6.57
O Palm Cove	-	9.13	-	10.13	-	11.13	-	12.13	-	1.13	-	2.13	-	3.13	-	4.13	-	5.13	-	6.13	-	7.07

Image provided courtesy of TransLink, Department of Transport and Main Roads (Effective, August 2018).

a Kadeem has just visited his wife who has had a baby at the Cairns Hospital. He is now on his way home to Kewarra Beach to finish preparing the nursery. If he arrives at the Hospital bus stop at 11:45 a.m., when will the next bus arrive and at what time will this bus arrive at his stop?

b Meghan has just finished her lecture at James Cook University and it is 2:10 p.m. She is going to Palm Cove to meet some friends. At what time will the next bus depart from the University?

c Angelo has a job interview at a company on Clifton Road at 12:30 p.m. He finishes a shift at the Cairns Hospital at 11 a.m. Determine if he can catch a bus after 11:00 a.m. that will allow him to get to his interview on time or whether he needs to rearrange his shift.

★5 The Brisbane Airport–Inner City–Gold Coast train timetable is displayed. Use this timetable to answer the following questions.

Airport–City to Varsity Lakes

outbound

QueenslandRail

Monday to Thursday

Station	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am
Domestic			5:04	5:34	6:04	6:34	7:04	7:34	7:49	8:04	8:19	8:34	8:49	9:04	9:19	9:34	9:49	10:04	10:19	10:34	11:04	11:34
International			5:08	5:38	6:08	6:38	7:08	7:38	7:53	8:08	8:23	8:38	8:53	9:08	9:23	9:38	9:53	10:08	10:23	10:38	11:08	11:38
Eagle Junction			**5:15**	**5:45**	**6:15**	**6:45**	**7:15**	**7:45**	**8:00**	**8:15**	**8:30**	**8:45**	**9:00**	**9:15**	**9:30**	**9:45**	**10:00**	**10:15**	**10:30**	**10:45**	**11:15**	**11:45**
Wooloowin			5:17	5:47	6:17	6:47	7:17	7:47	8:02	8:17	8:32	8:47	9:02	9:17	9:32	9:47	10:02	10:17	10:32	10:47	11:17	11:47
Albion	----	----	5:19	5:49	6:19	6:49	7:19	7:49	8:04	8:19	8:34	8:49	9:04	9:19	9:34	9:49	10:04	10:19	10:34	10:49	11:19	11:49
Bowen Hills	4:23	4:53	5:23	5:53	6:23	6:53	7:23	7:53	8:08	8:23	8:38	8:53	9:08	9:23	9:38	9:53	10:08	10:23	10:38	10:53	11:23	11:53
Fortitude Valley	4:25	4:55	5:25	5:55	6:25	6:55	7:25	7:55	8:10	8:25	8:40	8:55	9:10	9:25	9:40	9:55	10:10	10:25	10:40	10:55	11:25	11:55
Central arrive	**4:28**	**4:58**	**5:28**	**5:58**	**6:28**	**6:58**	**7:28**	**7:58**	**8:13**	**8:28**	**8:43**	**8:58**	**9:13**	**9:28**	**9:43**	**9:58**	**10:13**	**10:28**	**10:43**	**10:58**	**11:28**	**11:58**
Central depart	**4:29**	**4:59**	**5:29**	**5:59**	**6:29**	**6:59**	**7:29**	**7:59**	**8:14**	**8:29**	**8:44**	**8:59**	**9:14**	**9:29**	**9:44**	**9:59**	**10:14**	**10:29**	**10:44**	**10:59**	**11:29**	**11:59**
Roma Street arrive	4:32	5:02	5:32	6:02	6:32	7:02	7:32	8:02	8:17	8:32	8:47	9:02	9:17	9:32	9:48	10:02	10:17	10:32	10:48	11:02	11:32	12:02
Roma Street depart	4:32	5:02	5:32	6:02	6:32	7:02	7:32	8:02	8:17	8:32	8:47	9:02	----	9:32	----	10:02	10:17	10:32	----	11:02	11:32	12:02
South Brisbane	4:37	5:07	5:37	6:07	6:37	7:07	7:37	8:07	8:22	8:37	8:52	9:07		9:37		10:07	10:22	10:37		11:07	11:37	12:07
South Bank	4:39	5:09	5:39	6:09	6:39	7:09	7:39	8:09	8:24	8:39	8:54	9:09		9:39		10:09	10:24	10:39		11:09	11:39	12:09
Park Road	**4:42**	**5:12**	**5:42**	**6:12**	**6:42**	**7:12**	**7:42**	**8:12**	**8:27**	**8:42**	**8:57**	**9:12**		**9:42**		**10:12**	**10:27**	**10:42**		**11:12**	**11:42**	**12:12**
Altandi	4:57	5:27	5:57	6:27	6:57	7:27	7:57	8:27	----	8:57	----	9:27		9:57		10:27	----	10:57		11:27	11:57	12:27
Loganlea	5:10	5:40	6:10	6:40	7:10	7:40	8:10	8:40		9:10		9:40		10:10		10:40		11:10		11:40	12:10	12:40
Beenleigh	**5:20**	**5:50**	**6:20**	**6:50**	**7:20**	**7:50**	**8:20**	**8:50**		**9:20**		**9:50**		**10:20**		**10:50**		**11:20**		**11:50**	**12:20**	**12:50**
Ormeau	5:27	5:57	6:27	6:57	7:27	7:57	8:27	8:57		9:27		9:57		10:27		10:57		11:27		11:57	12:27	12:57
Coomera	5:32	6:02	6:32	7:02	7:32	8:02	8:32	9:02		9:32		10:02		10:32		11:02		11:32		12:02	12:32	1:02
Helensvale	5:37	6:07	6:37	7:07	7:37	8:07	8:37	9:07		9:37		10:07		10:37		11:07		11:37		12:07	12:37	1:07
Nerang	5:42	6:12	6:42	7:12	7:42	8:12	8:42	9:12		9:42		10:12		10:42		11:12		11:42		12:12	12:42	1:12
Robina	5:48	6:18	6:48	7:18	7:48	8:18	8:48	9:18		9:48		10:18		10:48		11:18		11:48		12:18	12:48	1:18
Varsity Lakes	5:52	6:22	6:52	7:22	7:52	8:22	8:52	9:22		9:52		10:22		10:52		11:22		11:52		12:22	12:52	1:22

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a Rachel is planning to visit her friend who lives on the Gold Coast. She is leaving from the Fortitude Valley terminal and is hoping to be in Robina just before 12 p.m. What is the latest time she could catch the train?

b Tracey is arriving from Thailand at 7 a.m. and is hoping to catch a train to Park Road terminal. Advise her as to which train she could catch from the International Terminal and the time this train would arrive at Park Road.

c Tom is meeting his friend, who has just flown in to Brisbane from Perth. Tom's friend wishes to catch the 9:04 a.m. train from the Domestic Terminal heading towards Varsity Lakes. At what time would Tom need to catch the train from Loganlea in order to meet his friend on the same train so that they can continue the journey together to Varsity Lakes?

d How long will it take Tom's friend to travel from the Domestic Terminal to the Varsity Lakes terminal?

Example 13 ★6 Jerry has just returned from his holiday in Cambodia. His plane lands at 6:30 a.m. at Brisbane International Airport and he expects it will take him 1 h to go through passport control, collect his luggage, go through customs and make his way to the train station. Jerry then needs to catch a train to Roma Street terminal, where he will change trains to get to Ipswich.

Use the timetable given in Question **5** together with the following timetable to determine a plan for Jerry's trip from the airport to Ipswich. Organise the information in a table such as the one shown. Justify your selection of times.

Location	Departure time	Destination	Arrival time
International Terminal			

City to Ipswich/Rosewood
outbound
QueenslandRail

Monday to Thursday

Comes from		CAB	CAB	CAB		CAB	CAB	CAB	NBR	CAB	CAB	NBR	CAB	NBR	CAB	CAB	NBR	CAB	CAB	NBR
Station	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	pm	pm	pm	pm
Bowen Hills		4:52	5:22	5:52	6:22	6:52	7:22	7:52	8:22	8:52	9:22	9:52	10:22	10:52	11:22	11:52	12:22	12:52	1:22	1:52
Fortitude Valley		4:54	5:24	5:54	6:24	6:54	7:24	7:54	8:24	8:54	9:24	9:54	10:24	10:54	11:24	11:54	12:24	12:54	1:24	1:54
Central arrive		**4:56**	**5:26**	**5:56**	**6:26**	**6:56**	**7:26**	**7:56**	**8:26**	**8:56**	**9:26**	**9:56**	**10:26**	**10:56**	**11:26**	**11:56**	**12:26**	**12:56**	**1:26**	**1:56**
Central depart		**4:58**	**5:28**	**5:58**	**6:28**	**6:58**	**7:28**	**7:58**	**8:28**	**8:58**	**9:28**	**9:58**	**10:28**	**10:58**	**11:28**	**11:58**	**12:28**	**12:58**	**1:28**	**1:58**
Roma Street		5:00	5:30	6:00	6:30	7:00	7:30	8:00	8:30	9:00	9:30	10:00	10:30	11:00	11:30	12:00	12:30	1:00	1:30	2:00
Milton		**5:03**	**5:33**	**6:03**	**6:33**	**7:03**	**7:33**	**8:03**	**8:33**	**9:03**	**9:33**	**10:03**	**10:33**	**11:03**	**11:33**	**12:03**	**12:33**	**1:03**	**1:33**	**2:03**
Auchenflower		5:05	5:35	6:05	6:35	7:05	7:35	8:05	8:35	9:05	9:35	10:05	10:35	11:05	11:35	12:05	12:35	1:05	1:35	2:05
Toowong		5:07	5:37	6:07	6:37	7:07	7:37	8:07	8:37	9:07	9:37	10:07	10:37	11:07	11:37	12:07	12:37	1:07	1:37	2:07
Taringa		5:10	5:40	6:10	6:40	7:10	7:40	8:10	8:40	9:10	9:40	10:10	10:40	11:10	11:40	12:10	12:40	1:10	1:40	2:10
Indooroopilly		**5:12**	**5:42**	**6:12**	**6:42**	**7:12**	**7:42**	**8:12**	**8:42**	**9:12**	**9:42**	**10:12**	**10:42**	**11:12**	**11:42**	**12:12**	**12:42**	**1:12**	**1:42**	**2:12**
Chelmer		5:14	5:44	6:14	6:44	7:14	7:44	8:14	8:44	9:14	9:44	10:14	10:44	11:14	11:44	12:14	12:44	1:14	1:44	2:14
Graceville		5:16	5:46	6:16	6:46	7:16	7:46	8:16	8:46	9:16	9:46	10:16	10:46	11:16	11:46	12:16	12:46	1:16	1:46	2:16
Sherwood		5:18	5:48	6:18	6:48	7:18	7:48	8:18	8:48	9:18	9:48	10:18	10:48	11:18	11:48	12:18	12:48	1:18	1:48	2:18
Corinda		5:20	5:50	6:20	6:50	7:20	7:50	8:20	8:50	9:20	9:50	10:20	10:50	11:20	11:50	12:20	12:50	1:20	1:50	2:20
Oxley		5:23	5:53	6:23	6:53	7:23	7:53	8:23	8:53	9:23	9:53	10:23	10:53	11:23	11:53	12:23	12:53	1:23	1:53	2:23
Darra		**5:26**	**5:56**	**6:26**	**6:56**	**7:26**	**7:56**	**8:26**	**8:56**	**9:26**	**9:56**	**10:26**	**10:56**	**11:26**	**11:56**	**12:26**	**12:56**	**1:26**	**1:56**	**2:26**
Wacol		5:30	6:00	6:30	7:00	7:30	8:00	8:30	9:00	9:30	10:00	10:30	11:00	11:30	12:00	12:30	1:00	1:30	2:00	2:30
Gailes		5:33	6:03	6:33	7:03	7:33	8:03	8:33	9:03	9:33	10:03	10:33	11:03	11:33	12:03	12:33	1:03	1:33	2:03	2:33
Goodna		5:35	6:05	6:35	7:05	7:35	8:05	8:35	9:05	9:35	10:05	10:35	11:05	11:35	12:05	12:35	1:05	1:35	2:05	2:35
Redbank		5:39	6:09	6:39	7:09	7:39	8:09	8:39	9:09	9:39	10:09	10:39	11:09	11:39	12:09	12:39	1:09	1:39	2:09	2:39
Riverview		5:42	6:12	6:42	7:12	7:42	8:12	8:42	9:12	9:42	10:12	10:42	11:12	11:42	12:12	12:42	1:12	1:42	2:12	2:42
Dinmore		5:45	6:15	6:45	7:15	7:45	8:15	8:45	9:15	9:45	10:15	10:45	11:15	11:45	12:15	12:45	1:15	1:45	2:15	2:45
Ebbw Vale		5:47	6:17	6:47	7:17	7:47	8:17	8:47	9:17	9:47	10:17	10:47	11:17	11:47	12:17	12:47	1:17	1:47	2:17	2:47
Bundamba		5:49	6:19	6:49	7:19	7:49	8:19	8:49	9:19	9:49	10:19	10:49	11:19	11:49	12:19	12:49	1:19	1:49	2:19	2:49
Booval		5:51	6:21	6:51	7:21	7:51	8:21	8:51	9:21	9:51	10:21	10:51	11:21	11:51	12:21	12:51	1:21	1:51	2:21	2:51
East Ipswich		5:54	6:24	6:54	7:24	7:54	8:24	8:54	9:24	9:54	10:24	10:54	11:24	11:54	12:24	12:54	1:24	1:54	2:24	2:54
Ipswich arrive		**5:56**	**6:26**	**6:56**	**7:26**	**7:56**	**8:26**	**8:56**	**9:26**	**9:56**	**10:26**	**10:56**	**11:26**	**11:56**	**12:26**	**12:56**	**1:26**	**1:56**	**2:26**	**2:56**
Change train	----	**Thru**	**CT**	-----	**CT**	**CT**	**CT**	-----	**CT**	----	**CT**	-----	**CT**	-----	**CT**	-----	**CT**	-----	**CT**	**CT**
Ipswich depart	**5:35**	**5:57**	**6:35**		**7:35**	**8:05**	**8:35**		**9:35**		**10:35**		**11:35**		**12:35**		**1:35**		**2:35**	**3:20**
Thomas Street	5:37	5:59	6:37		7:37	8:07	8:37		9:37		10:37		11:37		12:37		1:37		2:37	3:22
Wulkuraka	5:40	6:02	6:40		7:40	8:10	8:40		9:40		10:40		11:40		12:40		1:40		2:40	3:25
Karrabin	5:43	6:05	6:43		7:43	8:13	8:43		9:43		10:43		11:43		12:43		1:43		2:43	3:28
Walloon	5:47	6:09	6:47		7:47	8:17	8:47		9:47		10:47		11:47		12:47		1:47		2:47	3:32
Thagoona	5:52	6:14	6:52		7:52	8:22	8:52		9:52		10:52		11:52		12:52		1:52		2:52	3:37
Rosewood	5:56	6:18	6:56		7:56	8:26	8:56		9:56		10:56		11:56		12:56		1:56		2:56	3:41

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★7 Emma and Rob are staying at Northcliffe Hotel on the Gold Coast. They are planning to visit Movie World for the day and wish to arrive before the 9 o'clock opening time. They have a tram stop right outside their hotel at Northcliffe and they plan to catch the tram to Helensvale Station and then catch a bus from Helensvale to Movie World.

Determine a plan for their trip using the following table, ensuring that they arrive on time before the Movie World gates open at 9 a.m.

Hint Ensure that the chosen route is reasonable and can be clearly justified.

Organise the information in a table such as the one shown. Justify your selection of times.

Location	Mode	Departure time	Destination	Arrival time
Northcliffe				

Tram timetable

Northcliffe station	7:33 am	7:41 am	7:48 am	7:56 am	8:03 am
Surfers Paradise station	7:35 am	7:42 am	7:50 am	7:57 am	8:05 am
Cavill Avenue station	7:37 am	7:45 am	7:52 am	8:00 am	8:07 am
Cypress Avenue station	7:40 am	7:47 am	7:55 am	8:02 am	8:10 am
Surfers Paradise North station	7:41 am	7:49 am	7:56 am	8:04 am	8:11 am
Main Beach station	7:44 am	7:51 am	7:59 am	8:06 am	8:14 am
Broadwater Parklands station	7:46 am	7:54 am	8:01 am	8:09 am	8:16 am
Southport South station	7:48 am	7:55 am	8:03 am	8:10 am	8:18 am
Southport station	7:51 am	7:58 am	8:06 am	8:13 am	8:21 am
Nerang Street station	7:52 am	8:00 am	8:07 am	8:15 am	8:22 am
Queen Street station (Southport)	7:56 am	8:03 am	8:11 am	8:18 am	8:26 am
Griffith University station (Southport)	7:59 am	8:06 am	8:14 am	8:21 am	8:29 am
GCUH	8:00 am	8:08 am	8:15 am	8:23 am	8:30 am
Parkwood East station	8:05 am	8:12 am	8:20 am	8:27 am	8:35 am
Parkwood station	8:08 am	8:15 am	8:23 am	8:30 am	8:38 am
Helensvale Station	8:11 am	8:19 am	8:26 am	8:34 am	8:41 am

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Bus timetable

Route TX7 **Helensvale to Coomera**
servicing Helensvale, Wet 'n' Wild, Movie World, Oxenford, Dreamworld and Coomera

Monday to Friday

map ref	Route number	TX7	TX7	TX7	TX7	TX7	TX7	TX7	TX7	TX7	TX7	TX7	TX7	TX7	TX7	TX7	TX7	TX7	TX7	TX7
		am	am			am				am	am	pm	pm	pm	pm	pm	pm	pm	pm	pm
F	Helensvale station, stop C	8.44	8.59							11.34	11.44	12.14	12.44	1.14	1.44	2.14	2.44	3.14	3.44	4.14	4.44
E	Wet 'n' Wild	8.49	9.04							11.40	11.50	12.20	12.51	1.21	1.51	2.21	2.51	3.21	3.51	4.21	4.51
D	Movie World	8.53	9.08			Departs every 10 minutes				11.44	11.54	12.24	12.55	1.25	1.55	2.25	2.55	3.25	3.55	4.25	4.55
C	Siganto Dr near Trade Winds Dr	8.58	9.13			between 9am and 11.30am				11.49	11.59	12.29	1.00	1.30	2.00	2.30	3.00	3.30	4.00	4.30	5.00
B	Dreamworld	9.05	9.20							11.56	12.06	12.36	1.08	1.38	2.09	2.39	3.10	3.40	4.10	4.39	5.08
A	Coomera station	9.10	9.25							12.01	12.11	12.41	1.13	1.43	2.14	2.44	3.15	3.45	4.15	4.44	5.13

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10D Comparing travel times with various modes of transport

LEARNING GOAL

- Compare the time taken to travel a specific distance with various modes of transport

When is it essential to compare travel times?

When travelling, there are often various modes of transport available that can take you to your destination. It is important to look at the most time-efficient manner when deciding on the mode of transport, as this can save you a lot of time, especially if it is a journey that you take on a regular basis such as your daily trip to work.

When catching a flight, public transport, such as the QR City train (pictured), provides a more reliable estimate of travel time than traffic driving times.

WHAT YOU NEED TO KNOW

- To **calculate time difference travel times** (the time difference between departure and arrival in hours and minutes), first count the number of hours that have passed and then the number of minutes.
  - For example: Find the time difference between 2:43 p.m. and 4:08 p.m.
    2:43 p.m. to 3:43 p.m. = 1 h
    3:43 p.m. to 4 p.m. = 17 min
    4 p.m. to 4:08 p.m. = 8 min
    So, 1 h + 17 min + 8 min = 1 h 25 min.
- **Compare travel times** to decide which is the best travel option.
  Calculate the hours and minutes that it takes for each option, then check that the shortest time will still allow you to arrive before the required time.

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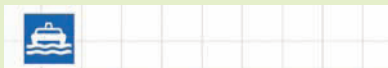
- Use timetables to **determine departure and arrival times**.
  - For example: Using the following timetable, if you are travelling by ferry from UQ St Lucia to the Riverside terminal and you depart at 1:18 p.m., you would arrive at 1:58 p.m.



Downstream service

Departs Terminal:	pm	pm
UQ St Lucia	1.18	1.33
West End	1.23	1.38
Guyatt Park	1.26	1.41
Regatta	1.30	1.45
Milton	1.34	1.49
North Quay	1.40	1.55
South Bank 1	1.44	1.59
QUT Gardens Point	1.48	2.03
Riverside	1.58	2.13
Sydney Street	2.06	2.21
Mowbray Park	2.09	2.24
New Farm Park	2.13	2.28

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Example 14 Comparing the travel times of various bus trips for a specific route

Chloe is heading to the Heritage Village from the centre of Rockhampton but she does not have a car. She has found that there are three bus options for her to choose from. Analyse each of the following options by determining the travel time and, hence, decide which option Chloe should choose if she wishes to minimise her travel time.

Option 1: Bus that departs at 9:16 a.m. and arrives at 10:29 a.m.

Option 2: Bus that departs at 9:20 a.m. and arrives at 10:18 a.m.

Option 3: Bus that departs at 9:31 and arrives at 10:15 a.m.

WORKING	THINKING
Option 1: 9:16 a.m. to 10:16 a.m. = 1 h 10:16 a.m. to 10:29 a.m. = 13 min Takes 1 h and 13 min.	Calculate the amount of time that each option takes by breaking up the time into parts.
Option 2: 9:20 a.m. to 10:18 a.m. = 58 min Takes 58 min.	

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Option 3: 9:31 a.m. to 10:01 a.m. = 30 min
10:01 a.m. to 10:15 a.m. = 14 min
Takes 44 min.

Chloe should take the bus that departs at 9:31 a.m., as it takes the least amount of time to get there. ← Select the option that takes the least amount of time.

Example 15 Comparing bus and ferry timetables, to find the earliest arrival time

It is currently 5 p.m. and Anthony is at South Bank wanting to get to QUT Gardens Point. He has two options for public transport.

Option 1: Anthony can catch a ferry from South Bank 1 terminal and go straight to QUT Gardens Point, which then requires a 9 min walk to access the campus.

Option 2: Anthony can get a bus at the South Bank bus station and go to Elizabeth Street, which then also requires a 9 min walk to reach the QUT campus.

Use the following timetables to determine the best option for Anthony's travel if he wishes to travel for the least amount of time. Justify your choice.

Elizabeth Street plus a 9 min walk to QUT

South Bank Busway Station	1:10 pm	2:10 pm	3:10 pm	4:10 pm	5:10 pm
Cultural Centre Station	1:13 pm	2:13 pm	3:13 pm	4:13 pm	5:13 pm
Elizabeth Street Stop 81 near George St, Brisbane City	1:20 pm	2:20 pm	3:20 pm	4:20 pm	5:20 pm

Ferry timetable

Departs Terminal:	pm	pm	pm	pm	pm	pm	pm	pm	pm	pm	pm	pm	pm	pm	pm
UQ St Lucia	4.22	....	4.33	....	4.40	4.48	....	5.00	5.03	....	5.18	5.20	....	5.33	....
West End	SE	....	4.38	....	SE	4.53	....	SE	5.08	....	5.23	SE	....	5.38	....
Guyatt Park	SE	....	4.41	....	SE	4.56	....	SE	5.11	....	5.26	SE	....	5.41	....
Regatta	SE	....	4.45	....	SE	5.00	....	SE	5.15	....	5.30	SE	....	5.45	....
Milton	SE	....	4.49	....	SE	5.04	....	SE	5.19	....	5.34	SE	....	5.49	....
North Quay	4.37	....	4.55	....	4.55	5.10	....	5.15	5.25	....	5.40	5.36	....	5.55	....
South Bank 1	....	....	4.59	....	....	5.14	....	....	5.29	....	5.44	SE	....	5.59	....
QUT Gardens Point	....	....	5.03	....	....	5.18	....	....	5.33	....	5.48	SE	....	6.03	....
Riverside	....	5.09	5.13	5.24	....	5.28	5.39	....	5.43	5.54	5.58	5.50	6.09	6.13	6.24
Sydney Street	....	5.17	5.21	5.32	....	5.36	5.47	....	5.51	6.02	6.06	SE	6.17	6.21	6.32
Mowbray Park	....	5.20	5.24	5.35	....	5.39	5.50	....	5.54	6.05	6.09	SE	6.20	6.24	6.35
New Farm Park	....	5.24	5.28	5.39	....	5.43	5.54	....	5.58	6.09	6.13	SE	6.24	6.28	6.39
Hawthorne	....	5.29	5.33	5.44	....	5.48	5.59	....	6.03	6.14	6.18	SE	6.29	6.33	6.44
Bulimba	....	5.34	5.38	5.49	....	5.53	6.04	....	6.08	6.19	6.23	SE	6.34	6.38	6.49
Teneriffe	....	5.38	5.42	5.53	....	5.57	6.08	....	6.12	6.23	6.27	6.07	6.38	6.42	6.53
Bretts Wharf	....	....	5.48	....	....	6.03	....	....	6.18	....	6.33	SE	....	6.48	....
Apollo Road	....	....	5.51	....	....	6.06	....	....	6.21	....	6.36	6.15	....	6.51	....
Northshore Hamilton	....	....	5.56	....	....	6.11	....	....	6.26	....	6.41	6.20	....	6.56	....

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WORKING	THINKING
Bus option is 5:10 p.m. to 5:20 p.m. = 10 min plus a 9 min walk = 19 min, so arrive at 5:29 p.m.	Check the bus departure and arrival times to calculate the length of time for the trip.
Ferry option is 5:14 p.m. to 5:18 p.m. = 4 min plus a 9 min walk, which is 13 min in total, so arrive at 5:27 p.m.	Check the ferry departure and arrival times to calculate the length of time for the trip.
The ferry option is the best, as it requires less travel time and Anthony will arrive at QUT earlier than the bus option.	Choose the shortest travel time that arrives the earliest.

Exercise 10D

FUNDAMENTALS

1 Write down the missing numbers in the following calculation of the time difference, in hours and minutes, between 2.43 p.m. and 4:08 p.m.

a 2:43 p.m. to _____ p.m. = 1 h
b 3:43 p.m. to 4 p.m. = ___ min
c 4 p.m. to ____ p.m. = ___ min
d 1 h + ___ min + ___ min = __ h __ min

APPLICATIONS

SF: 2–6 | CF: – | CU: –

Example 14

2 Suzanna is travelling from Hervey Bay to Maryborough and she has found two options for transport. Analyse each of these options by determining the travel time and, hence, decide which option Suzanna should choose if she wishes to minimise her travel time.

Hint Find difference of whole hours and add difference of minutes.

Option 1: Departs Ansons Rd at 10:51 a.m. and arrives in Maryborough at 12:26 p.m.
Option 2: Departs Ansons Rd at 9:21 a.m. and arrives in Maryborough at 11:26 a.m.

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3 Noah is travelling from Nambour Station to Landsborough Station. He can either catch a train or a bus. Analyse each of the following options by determining the travel time and, hence, decide which option Noah should choose if he wishes to minimise his travel time.

Option 1: Train departing Nambour at 8:18 a.m. and arriving at Landsborough at 8:46 a.m.

Option 2: Bus departing Nambour at 8:35 a.m. and arriving at Landsborough at 9:01 a.m.

★4 Refer to the following combined bus and train timetable for the Sunshine Coast line and answer the following.

Bus and train timetable

Monday to Thursday (continued)

Station	am	am	am	am	am	am	am	am	pm	pm	pm	pm	pm	pm	pm	pm
Gympie North																**1:24**
Traveston																1:42
Cooran																1:48
Pomona																1:55
Cooroy																2:03
Eumundi																2:09
Yandina				----			----			----			----			2:16
Nambour bus	----		----	**Bus**	----		**Bus**	----		**Bus**	----		**Bus**	----		
Nambour	**7:26**		**8:08**	**8:35**	**9:08**		**9:50**	**10:38**		**11:15**	**12:08**		**12:30**	**1:38**		**2:25**
Woombye	7:31		8:13	exp	9:13		9:57	10:43		11:22	12:13		12:37	1:43		2:31
Palmwoods	7:35		8:17	exp	9:17		10:05	10:47		11:30	12:17		12:45	1:47		2:35
Eudlo*	7:41		8:23	exp	9:23		10:13	10:53		11:38	12:23		12:53	1:53		2:41
Mooloolah	7:48		8:30	exp	9:30		10:21	11:00		11:46	12:30		1:01	2:00		2:56
Landsborough	**7:54**		**8:36**	**9:01**	**9:36**		**10:33**	**11:06**		**11:58**	**12:36**		**1:13**	**2:06**		**3:02**
Australia Zoo				*exp*			*exp*			*exp*			*1:18*			
Beerwah	7:59		8:41	exp	9:41		exp	11:11		exp	12:41		1:23	2:11		3:07
Glass House Mtns	8:04		8:46	exp	9:46		exp	11:16		exp	12:46		1:31	2:16		3:12
Beerburrum	8:12		8:54	exp	9:54		exp	11:24		exp	12:54		1:38	2:24		3:20
Elimbah	8:17		8:59	exp	9:59		exp	11:29		exp	12:59		1:45	2:29		3:25
Caboolture arrive	**8:23**		**9:05**	**9:27**	**10:05**		**10:59**	**11:35**		**12:24**	**1:05**		**1:55**	**2:35**		**3:32**
Change service	**Thru**	----	**Thru**	**CS**	**Thru**	----	**CS**	**Thru**	----	**CS**	**Thru**	----	**CS**	**Thru**	----	**Thru**
Caboolture depart	**8:23**	**8:35**	**9:05**	**9:35**	**10:05**	**10:35**	**11:05**	**11:35**	**12:05**	**12:35**	**1:05**	**1:35**	**2:05**	**2:35**	**3:05**	**3:32**
Morayfield	exp	8:38	9:08	9:38	10:08	10:38	11:08	11:38	12:08	12:38	1:08	1:38	2:08	2:38	3:08	exp
Burpengary	exp	8:43	9:13	9:43	10:13	10:43	11:13	11:43	12:13	12:43	1:13	1:43	2:13	2:43	3:13	exp
Narangba	exp	8:47	9:17	9:47	10:17	10:47	11:17	11:47	12:17	12:47	1:17	1:47	2:17	2:47	3:17	exp
Dakabin	exp	8:51	9:21	9:51	10:21	10:51	11:21	11:51	12:21	12:51	1:21	1:51	2:21	2:51	3:21	exp
Petrie	**8:39**	**8:56**	**9:26**	**9:56**	**10:26**	**10:56**	**11:26**	**11:56**	**12:26**	**12:56**	**1:26**	**1:56**	**2:26**	**2:56**	**3:26**	**3:48**

a Dennika has a job interview in Eudlo at 10:30 a.m. She is departing from Woombye and must be on time for her interview. By considering the timetables given:

i Identify the possible transport options for Dennika to travel from Woombye to Eudlo that will allow her to arrive before 10:30 a.m.

ii Analyse each option by determining the travel time.

iii Determine the best mode of transport for Dennika if she wishes to travel for the least amount of time.

Hint The bus part of this timetable is headed 'Bus'.

Hint An express service doesn't stop at places marked 'exp'.

b Cooper is heading to Australia Zoo for the afternoon. He would like to depart Palmwoods between 12 p.m. and 1 p.m. He can either catch the bus or the train. The train would also require a 6 min bus drive from Beerwah Station.

i Determine whether the train or the bus departs Palmwoods on a more regular basis.

ii Analyse the total travel time for the bus trip and for the train trip.

iii Decide which option would be best for Cooper if he wishes to travel for the least amount of time.

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Example 15 ★5 Lian and Phil are currently staying at a hotel on Breaker Street, Main Beach. They wish to go to a friend's house, who lives near the Broadbeach South station, for breakfast at 9 a.m. They have two possible modes of transport to get to their destination.

Option 1: Catch the tram from Main Beach station and hop off at Broadbeach South station.

Option 2: Catch a bus from the Main Beach Tourist Park and hop off at the Broadbeach South station.

Using the following tram and bus timetables, advise Lian and Phil of the best option and give reasons for this selection.

Tram timetable

Main Beach station	8:33 am	8:40 am	8:48 am	8:55 am	9:03 am
Surfers Paradise North station	8:36 am	8:43 am	8:51 am	8:58 am	9:06 am
Cypress Avenue station	8:38 am	8:45 am	8:53 am	9:00 am	9:08 am
Cavill Avenue station	8:41 am	8:48 am	8:56 am	9:03 am	9:11 am
Surfers Paradise station	8:43 am	8:50 am	8:58 am	9:05 am	9:13 am
Northcliffe station	8:44 am	8:52 am	8:59 am	9:07 am	9:14 am
Florida Gardens station	8:46 am	8:54 am	9:01 am	9:09 am	9:16 am
Broadbeach North station	8:49 am	8:56 am	9:04 am	9:11 am	9:19 am
Broadbeach South station	8:51 am	8:58 am	9:06 am	9:13 am	9:21 am

Bus timetable

Route 705 **Sea World/Main Beach to Broadbeach**
servicing Sea World/Main Beach, Surfers Pardise, Pacific Fair and Broadbeach South station

Monday to Friday

map ref	Route number	705	705	705	705	705	705	705	705	705	705	705	705	705	705	705	705	705	705	705	705
		am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am
H	Sea World	4.07	4.37	5.07	5.37	6.07	6.22	6.37	6.52	7.07	7.22	7.37	7.52	8.07	8.22	8.37	8.52	9.07	9.22	9.37	9.52
G	Main Beach Tourist Park	4.09	4.39	5.09	5.39	6.09	6.24	6.39	6.54	7.09	7.24	7.39	7.54	8.09	8.24	8.39	8.54	9.09	9.24	9.40	9.55
F	Surfers Paradise, Beach Rd	4.16	4.46	5.16	5.47	6.18	6.33	6.48	7.03	7.18	7.34	7.48	8.04	8.19	8.34	8.49	9.04	9.19	9.34	9.49	10.04
E	Old Burleigh Rd near Wharf St	4.19	4.49	5.19	5.50	6.22	6.37	6.52	7.07	7.22	7.38	7.53	8.09	8.24	8.39	8.54	9.09	9.24	9.39	9.54	10.09
D	Broadbeach Mall - Surf Pde	4.23	4.53	5.23	5.54	6.28	6.43	6.58	7.13	7.28	7.44	7.59	8.14	8.30	8.45	9.00	9.15	9.30	9.45	10.00	10.15
C	The Star Casino	4.26	4.56	5.26	5.57	6.31	6.46	7.01	7.16	7.31	7.47	8.02	8.17	8.33	8.48	9.03	9.18	9.33	9.48	10.03	10.18
B	Pacific Fair	4.30	5.00	5.30	6.02	6.36	6.51	7.06	7.21	7.36	7.52	8.07	8.22	8.38	8.53	9.09	9.24	9.39	9.54	10.09	10.24
A	Broadbeach South station	4.33	5.03	5.33	6.05	6.39	6.54	7.09	7.24	7.39	7.55	8.10	8.25	8.41	8.56	9.12	9.27	9.42	9.57	10.12	10.27

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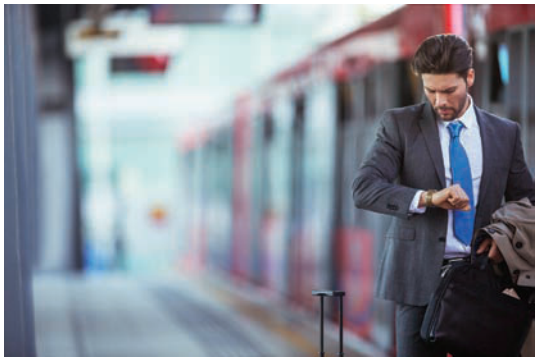
★6 Ryan starts work at 7 a.m. in South Bank and lives at Wynnum. He must catch either a bus or a train to work daily. If he catches the train, he must drive from home to Wynnum Central Station first, but he lives only a short walking distance from the bus stop.



a Use the following timetables to identify at least three travel options for Ryan.

b Analyse each of these options by calculating the total travel time.

c Discuss which travel option you believe to be the best for Ryan, giving reasons for your choice.

Bus timetable

Routes 214, 215, 220

Wynnum, Carindale and Cannon Hill to City

servicing Wynnum, Manly, Carindale, Belmont, Tingalpa, Cannon Hill, Morningside, Norman Park, Coorparoo, Woolloongabba, Cultural Centre and City

Monday to Friday

map ref	Route number	220	214	215	214	214	214	214	214	214	214	215	220	215	220	215	220	215	220	215	220
		am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	pm	pm	pm
A	Pandanus Beach	5.47	-	-	-	-	-	-	-	-	-	-	9.10	-	10.19	-	11.06	-	12.06	-	1.06
B	Wynnum West, Moreton Bay N. Home stop 55	5.55	-	-	-	-	-	-	-	-	-	-	9.20	-	10.28	-	11.15	-	12.15	-	1.15
C	Moreton Bay College	6.05	-	-	-	-	-	-	-	-	-	-	9.33	-	10.41	-	11.28	-	12.28	-	1.28
D	Carindale Interchange A	-	-	6.30	-	-	-	-	-	-	-	8.55	-	9.55	-	10.55	-	11.55	-	12.55	-
E	Tingalpa, Wynnum Rd stop 46/42	6.11	-	6.45	-	-	-	-	-	-	-	9.10	9.38	10.10	10.46	11.10	11.33	12.11	12.33	1.11	1.33
F	Cannon Hill Interchange A	6.16	6.45	6.53	7.05	7.20	7.35	7.50	8.05	8.20	8.35	9.18	9.45	10.18	10.52	11.18	11.39	12.17	12.39	1.17	1.39
G	Norman Park	6.27	6.56	7.03	7.19	7.33	7.48	8.03	8.18	8.35	8.47	9.28	9.57	10.28	11.04	11.28	11.51	12.28	12.51	1.28	1.51
H	Woolloongabba station PL1	6.33	7.04	7.11	7.31	7.47	8.03	8.19	8.34	8.47	8.58	9.36	10.05	10.36	11.11	11.36	11.58	12.36	12.58	1.36	1.58
I	Mater Hill station PL1	6.35	7.06	7.13	7.34	7.50	8.08	8.24	8.39	8.51	9.02	9.38	10.07	10.38	11.13	11.38	12.00	12.38	1.00	1.38	2.00
J	South Bank Busway station PL1	6.38	7.09	7.15	7.39	7.55	8.14	8.31	8.46	8.56	9.07	9.40	10.10	10.40	11.16	11.40	12.03	12.40	1.03	1.40	2.03
K	Cultural Centre station PL1	6.42	7.13	7.17	7.44	8.00	8.21	8.38	8.53	9.01	9.12	9.42	10.15	10.42	11.20	11.42	12.07	12.42	1.07	1.42	2.07
L	City, Queen St station	6.47	7.17	7.29	7.49	8.08	8.29	8.46	9.01	9.09	9.20	9.54	10.20	10.54	11.25	11.54	12.12	12.48	1.12	1.48	2.12

Image provided courtesy of TransLink, Department of Transport and Main Roads (Effective, August 2018).

Train timetable

Cleveland to City

inbound

QueenslandRail

Monday to Thursday

Station	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am	am
Cleveland	4:39	5:09	5:24	5:39	6:09		6:24			6:54		7:09		7:24		7:39		7:54		8:24
Ormiston	4:41	5:11	5:26	5:41	6:11		6:26			6:56		7:11		7:26		7:41		7:56		8:26
Wellington Point	4:45	5:15	5:30	5:45	6:14		6:29			6:59		7:14		7:29		7:45		8:00		8:30
Birkdale	4:48	5:18	5:33	5:48	6:17		6:32			7:02		7:17		7:32		7:48		8:03		8:33
Thorneside	4:52	5:22	5:37	5:52	6:20		6:35			7:05		7:20		7:35		7:52		8:07		8:37
Lota	4:55	5:25	5:40	5:55	6:23	----	6:38	----	----	7:08	----	7:23	----	7:38	----	7:55	----	8:10		8:40
Manly	**4:58**	**5:28**	**5:43**	**5:58**	**6:26**	**6:28**	**6:41**	**6:43**	**6:58**	**7:11**	**7:13**	**7:26**	**7:28**	**7:41**	**7:43**	**7:58**	**8:06**	**8:13**		**8:43**
Wynnum Central	5:00	5:30	5:45	6:00	exp	6:30	exp	6:45	7:00	exp	7:15	exp	7:30	exp	7:45	8:00	8:08	8:15		8:45
Wynnum	5:02	5:32	5:47	6:02	exp	6:32	exp	6:47	7:02	exp	7:17	exp	7:32	exp	7:47	8:02	8:10	8:17		8:47
Wynnum North	5:04	5:34	5:49	6:04	exp	6:34	exp	6:49	7:04	exp	7:19	exp	7:34	exp	7:49	8:04	8:12	8:19		8:49
Lindum	5:07	5:37	5:52	6:07	exp	6:37	exp	6:52	7:07	exp	7:22	exp	7:37	exp	7:52	8:07	8:15	8:22		8:52
Hemmant	5:09	5:39	5:54	6:09	exp	6:39	exp	6:54	7:09	exp	7:24	exp	7:39	exp	7:54	8:09	8:17	8:24		8:54
Murarrie	5:13	5:43	5:58	6:13	exp	6:43	exp	6:58	7:13	exp	7:28	exp	7:43	exp	7:58	8:13	8:21	8:28	----	8:58
Cannon Hill	5:16	5:46	6:01	6:16	exp	6:46	exp	7:01	7:16	exp	7:31	exp	7:46	exp	8:01	8:16	8:24	8:31	8:39	9:01
Morningside	5:19	5:49	6:04	6:19	6:42	6:49	6:57	7:04	7:19	7:27	7:34	7:42	7:49	7:57	8:04	8:19	8:27	8:34	8:42	9:04
Norman Park	5:22	5:52	6:07	6:22	6:45	6:52	7:00	7:07	7:22	7:30	7:37	7:45	7:52	8:00	8:07	8:22	8:30	8:37	8:45	9:07
Coorparoo	5:24	5:54	6:09	6:24	6:47	6:54	7:02	7:09	7:24	7:32	7:39	7:47	7:54	8:02	8:09	8:24	8:32	8:39	8:47	9:09
Buranda	5:26	5:56	6:11	6:26	6:49	6:56	7:04	7:11	7:26	7:34	7:41	7:49	7:56	8:04	8:11	8:26	8:34	8:41	8:49	9:11
Park Road	**5:29**	**5:59**	**6:14**	**6:29**	**6:52**	**6:59**	**7:07**	**7:14**	**7:29**	**7:37**	**7:44**	**7:52**	**7:59**	**8:07**	**8:14**	**8:29**	**8:37**	**8:44**	**8:52**	**9:14**
South Bank	5:32	6:02	6:17	6:32	6:55	7:02	7:10	7:17	7:32	7:40	7:47	7:55	8:02	8:10	8:17	8:32	8:40	8:47	8:55	9:17
South Brisbane	5:34	6:04	6:19	6:34	6:57	7:04	7:12	7:19	7:34	7:42	7:49	7:57	8:04	8:12	8:19	8:34	8:42	8:49	8:57	9:19
Roma Street	5:39	6:09	6:24	6:39	7:02	7:09	7:17	7:24	7:39	7:47	7:54	8:02	8:09	8:17	8:24	8:39	8:47	8:54	9:02	9:24
Central arrive	**5:41**	**6:11**	**6:26**	**6:41**	**7:04**	**7:11**	**7:19**	**7:26**	**7:41**	**7:49**	**7:56**	**8:04**	**8:11**	**8:19**	**8:26**	**8:41**	**8:49**	**8:56**	**9:04**	**9:26**
Central depart	**5:43**	**6:13**	**6:28**	**6:43**	**7:06**	**7:13**	**7:21**	**7:28**	**7:43**	**7:51**	**7:58**	**8:06**	**8:13**	**8:23**	**8:28**	**8:43**	**8:53**	**8:58**	**9:06**	**9:28**
Fortitude Valley	5:45	6:15	6:30	6:45	7:08	7:15	7:23	7:30	7:45	7:53	8:00	8:08	8:15	8:25	8:30	8:45	8:55	9:00	9:08	9:30
Bowen Hills	5:48	6:18	6:33	6:48	7:11	7:18	7:26	7:33	7:48	7:56	8:03	8:11	8:18	8:28	8:33	8:48	8:58	9:03	9:11	9:33
Continues to	SHG	SHG	SHG	SHG		SHG		SHG	SHG		SHG		SHG	DBN	SHG	SHG	DBN	SHG		NTG

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10E Interpreting complex timetables COMPLEX

LEARNING GOAL

- Read and interpret tables such as tidal times, moon phases and sunrise/sunset charts

When is it essential to interpret complex timetables?

Timetables are not only used for information about public transport. They are also necessary in many forms, including tidal charts, moon phases and sunrise/sunset charts.

Tidal charts record the high and low tides of a local area of ocean; moon phase charts record when the sunlit part of the moon has a variety of shapes, such as the full moon and new moon; and sunrise and sunset charts tell us the time for the first and last ray of sunshine for the day.

As the tide rises relentlessly along Rainbow Beach, Qld, every year it submerges some 4WDs! Local tide times and the period of safe travel is essential knowledge.

WHAT YOU NEED TO KNOW

- **Sunrise/sunset charts** Sunset and sunrise is measured when the first ray of light (sunrise) or last ray of light (sunset) can be seen. The Sun will always rise in the east and set in the west because the Earth spins in an easterly direction. Sunrise and sunset times vary from place to place and throughout the year.
- **Moon phases** The lunar phase or phase of the Moon is the shape of the directly sunlit portion of the Moon as seen from Earth. The lunar phases cyclically change as the Moon orbits Earth, according to the shifting positions of the Moon and Sun relative to Earth.

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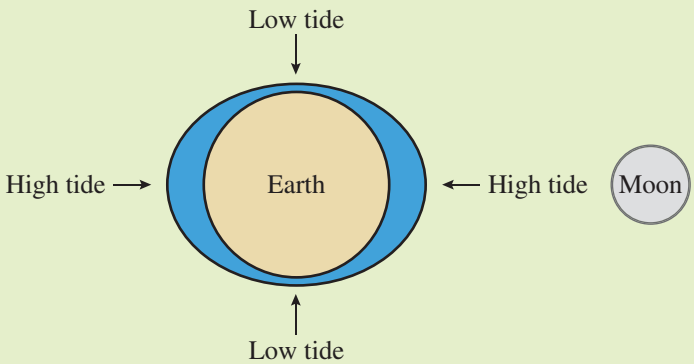
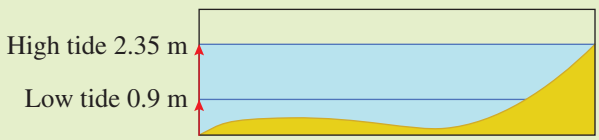
The Moon's phase cycle repeats, on average, every 29.53 days.

- **Tides** are the rise and fall of local sea levels that are caused by gravitational forces from the Moon and Sun combined with the rotation of Earth. The diagram shows a simplified Earth with exaggerated tide heights.



- **Tide tables** for all major coastal locations, with predicted tide times and heights, are published each year by the Bureau of Meteorology. Maritime Safety Queensland produces Queensland tide tables, sunrise and sunset times, and moon rise and set times.
- There are two high tides and two low tides every 24 hours. Tide heights vary from place to place and from day to day. Each high tide and low tide are approximately 6 hours apart. The safest beach driving time is within 2 hours of low tide.
  - For example: The diagram illustrates a 0.9 metre low tide, increasing to a 2.35 metre high tide.



  - The Australian Maritime Safety Authority operates the tide gauge network around the coast.

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Example 16 Reading and interpreting a tidal chart

Terry plans to go on a 4WD adventure leaving Sunday morning, 26th November, and returning Tuesday morning, 28th November. His trip includes a 1 hour drive up the beach, driving only within 2 hours of low tide.

a Identify the time and height of the first low tide on Sunday 26th November.

b Determine the times that Terry could start his beach driving on that day.

c Identify the time Terry should start his return on Tuesday.

SAT 25 Nov	**SUN** 26 Nov	**MON** 27 Nov	**TUE** 28 Nov	**WED** 29 Nov
↓ 5:15 a.m. 0:72 m	↑ 12:45 a.m. 1:24 m	↑ 2:07 a.m. 1:28 m	↑ 3:16 a.m. 1:39 m	↑ 4:11 a.m. 1:53 m
↑ 12:14 p.m. 1:67 m	↓ 6:14 a.m. 0:8 m	↓ 7:29 a.m. 0:83 m	↓ 8:51 a.m. 0:82 m	↓ 10:02 a.m. 0:76 m
↓ 7:05 p.m. 0:76 m	↑ 1:12 p.m. 1:63 m	↑ 2:17 p.m. 1:63 m	↑ 3:18 a.m. 1:66 m	↑ 4:12 p.m. 1:69 m
	↓ 8:12 p.m. 0:73 m	↓ 9:09 p.m. 0:67 m	↓ 10:00 p.m. 0:58 m	↓ 10:46 p.m. 0:47 m

WORKING	THINKING
a Low tide is at 6:14 a.m., with height 0.8 m.	Low tide times are beside the 'down arrowhead' symbol and have lower heights.
b 26th November: Start beach driving between 4:14 a.m. and 7:14 a.m.	Start between 6:14 a.m. minus 2 hours and 6:14 a.m. plus 1 hour (as beach trip takes 1 hour).
c 28th November: Start return from camp between 6:51 a.m. and 9:51 a.m.	Start between 8:51 a.m. minus 2 hours and 8:51 a.m. plus 1 hour (as beach trip takes 1 hour).

Exercise 10E

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words.

a The _____ of the Moon is the shape of the directly _____ portion, as seen from Earth.

b Tides are the rise and fall of local ____ levels caused by _____ forces from the Moon, Sun and the rotation of Earth.

c There are __ high tides and __ low tides every 24 hours.

d The safest beach driving time is within __ hours either side of low tide.

e Tide tables are published each year for all major coastal _____, with predicted tide _____ and _____.

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2 Use the information in the Moon phases timetable to answer the following.

A new moon.

a Identify the date in November when there is the new moon.

b Identify the date in April when there is the first quarter moon.

c Identify the date in July when there is a full moon.

d Identify the month in which there are two full moons.

e Identify the month in which there are two first quarter moons.

Moon phases for Brisbane 2020

Lunation	New Moon		First Quarter		Full Moon		Third Quarter		Duration
1200			3 Jan	2:45 pm	11 Jan	5:21 am	17 Jan	10:58 pm	29d 16h 29m
1201	25 Jan	7:42 am	2 Feb	11:41 am	9 Feb	5:33 pm	16 Feb	8:17 am	29d 17h 50m
1202	24 Feb	1:32 am	3 Mar	5:57 am	10 Mar	3:47 am	16 Mar	7:34 pm	29d 17h 56m
1203	24 Mar	7:28 pm	1 Apr	8:21 pm	8 Apr	12:35 pm	15 Apr	8:56 am	29d 16h 58m
1204	23 Apr	12:25 pm	1 May	6:38 am	7 May	8:45 pm	15 May	12:02 am	29d 15h 13m
1205	23 May	3:38 am	30 May	1:29 pm	6 Jun	5:12 am	13 Jun	4:23 pm	29d 13h 03m
1206	21 Jun	4:41 pm	28 Jun	6:15 pm	5 Jul	2:44 pm	13 Jul	9:28 am	29d 10h 51m
1207	21 Ju1	3:32 am	27 Jul	10:32 pm	4 Aug	1:58 am	12 Aug	2:44 am	29d 9h 09m
1208	19 Aug	12:41 pm	26 Aug	3:57 am	2 Sep	3:22 pm	10 Sep	7:25 pm	29d 8h 19m
1209	17 Sep	9:00 pm	24 Sep	11:54 am	2 Oct	7:05 am	10 Oct	10:39 am	29d 8h 31m
1210	17 Oct	5:31 am	23 Oct	11:22 pm	1 Nov	12:49 am	8 Nov	11:46 pm	29d 9h 36m
1211	15 Nov	3:07 pm	22 Nov	2:45 pm	30 Nov	7:29 pm	8 Dec	10:36 am	29d 11h 09m
1212	15 Dec	2:16 am	22 Dec	9:41 am	30 Dec	1:28 pm			29d 12h 44m

3 Use the information in the tidal chart to answer the following.

Bugatti Reef, QLD – January 2018

WED 3 JAN		THU 4 JAN		FRI 5 JAN		SAT 6 JAN		SUN 7 JAN		MON 8 JAN		TUE 9 JAN	
LOW	4:04 a.m. 0.19 m	LOW	4:51 a.m. 0.32 m	HIGH	12:02 a.m. 2.22 m	HIGH	12:59 a.m. 2.12 m	HIGH	2:11 a.m. 2.06 m	HIGH	3:39 a.m. 2.08 m	HIGH	5:07 a.m. 2.22 m
HIGH	11:00 a.m. 3.45 m	HIGH	11:46 a.m. 3.36 m	LOW	5:40 a.m. 0.51 m	LOW	6:35 a.m. 0.75 m	LOW	7:41 a.m. 1.00 m	LOW	9:06 a.m. 1.21 m	LOW	10:44 a.m. 1.29 m
LOW	5:10 p.m. 0.67 m	LOW	6:05 p.m. 0.73 m	HIGH	12:36 p.m. 3.19 m	HIGH	1:30 p.m. 2.97 m	HIGH	2:32 p.m. 2.74 m	HIGH	3:43 p.m. 2.54 m	HIGH	4:56 p.m. 2.40 m
HIGH	11:10 p.m. 2.31 m			LOW	7:08 p.m. 0.79 m	LOW	8:18 p.m. 0.84 m	LOW	9:28 p.m. 0.85 m	LOW	10:35 p.m. 0.82 m	LOW	11:32 p.m. 0.76 m

a On the evening of Thursday 4th January, determine the time when the tide will be at its lowest.

b In the morning of 9th January, determine the depth at the lowest tide.

c On Saturday 6th January, determine whether the tide is at the lowest in the morning or the evening.

d An average king tide for this region is around 3.8 metres. Identify the day on which the tide comes closest to this.

e Identify the day and time when the tide reaches the lowest height.

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4 This chart lists the sunrise and sunset times for Charters Towers, Qld in July 2020. Use the data to answer the questions.

2020	Sunrise/Sunset		Daylength	
Jul	Sunrise	Sunset	Length	Difference
1	6:50 am (66°)	5:46 pm (294°)	10:56:07	+0:12
2	6:50 am (66°)	5:47 pm (294°)	10:56:23	+0:15
3	6:50 am (66°)	5:47 pm (294°)	10:56:39	+0:16
4	6:50 am (66°)	5:47 pm (294°)	10:56:57	+0:17
5	6:50 am (66°)	5:48 pm (294°)	10:57:15	+0:18
27	6:46 am (70°)	5:56 pm (290°)	11:09:14	+0:43
28	6:46 am (70°)	5:56 pm (290°)	11:09:58	+0:44
29	6:46 am (70°)	5:56 pm (290°)	11:10:44	+0:45
30	6:45 am (71°)	5:57 pm (289°)	11:11:30	+0:46
31	6:45 am (71°)	5:57 pm (289°)	11:12:17	+0:47

a On 4th July, identify the times that sunrise and sunset take place.
b Of the days between the 1st and 31st of July, identify the day that has the most amount of daylight.
c Identify the date in July that has the earliest sunrise.
d Identify the date in July that has the latest sunset.
e What is the difference in length of the day from 1 July to 31 July?

APPLICATIONS

SF: – | CF: 5–10 | CU: 11

★5 In some areas, Aboriginal and Torres Strait Islander peoples consider a full moon to be a ceremony time. This is when ceremonies involving large groups of people, storytelling, song and dance have often taken place in the past. Having a ceremony during a full moon holds the advantage of brighter light and a higher chance of calm weather. Alinta is planning to organise a full moon ceremony in the middle of the year of 2020.

Use the moon phases chart to identify the possible dates for this ceremony.

Lunation	New Moon		First Quarter		Full Moon		Third Quarter		Duration
1200			3 Jan	2:45 pm	11 Jan	5:21 am	17 Jan	10:58 pm	29d 16h 29m
1201	25 Jan	7:42 am	2 Feb	11:41 am	9 Feb	5:33 pm	16 Feb	8:17 am	29d 17h 50m
1202	24 Feb	1:32 am	3 Mar	5:57 am	10 Mar	3:47 am	16 Mar	7:34 pm	29d 17h 56m
1203	24 Mar	7:28 pm	1 Apr	8:21 pm	8 Apr	12:35 pm	15 Apr	8:56 am	29d 16h 58m
1204	23 Apr	12:25 pm	1 May	6:38 am	7 May	8:45 pm	15 May	12:02 am	29d 15h 13m
1205	23 May	3:38 am	30 May	1:29 pm	6 Jun	5:12 am	13 Jun	4:23 pm	29d 13h 03m
1206	21 Jun	4:41 pm	28 Jun	6:15 pm	5 Jul	2:44 pm	13 Jul	9:28 am	29d 10h 51m
1207	21 Ju1	3:32 am	27 Jul	10:32 pm	4 Aug	1:58 am	12 Aug	2:44 am	29d 9h 09m
1208	19 Aug	12:41 pm	26 Aug	3:57 am	2 Sep	3:22 pm	10 Sep	7:25 pm	29d 8h 19m
1209	17 Sep	9:00 pm	24 Sep	11:54 am	2 Oct	7:05 am	10 Oct	10:39 am	29d 8h 31m
1210	17 Oct	5:31 am	23 Oct	11:22 pm	1 Nov	12:49 am	8 Nov	11:46 pm	29d 9h 36m
1211	15 Nov	3:07 pm	22 Nov	2:45 pm	30 Nov	7:29 pm	8 Dec	10:36 am	29d 11h 09m
1212	15 Dec	2:16 am	22 Dec	9:41 am	30 Dec	1:28 pm			29d 12h 44m

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★6 Sarrita wants to know what the moon will be like on her birthday. She is planning an outdoor birthday party and she has heard that the weather is more likely to be calm on the day of a full moon. Sarrita's actual birthday is 10th September and she would like to have her party on a Saturday night, so she is considering having it on 7th September.

2019 Lunar Phases - Brisbane (Australia/Brisbane) Time

● New Moon		◖ First Quater		○ Full Moon		◗ Third Quater		Lunation
Jan. 6, Su	*11:29*	Jan. 14, Mo	*16:46*	Jan. 21, Mo	*15:17*	Jan. 28, Mo	*07:12*	1188
Feb. 5, Tu	*07:04*	Feb. 13, We	*08:26*	Feb. 20, We	*01:53*	Feb. 26, Tu	*21:29*	1189
Mar. 7, Th	*02:05*	Mar. 14, Th	*20:26*	Mar. 21, Th	*11:43*	Mar. 28, Th	*14:11*	1190
Apr. 5, Fr	*18:52*	Apr. 13, Sa	*05:06*	Apr. 19, Fr	*21:12*	Apr. 27, Sa	*08:19*	1191
May 5, Su	*08:47*	May 12, Su	*11:13*	May 19, Su	*07:11*	May 27, Mo	*02:34*	1192
June 3, Mo	*20:02*	June 10, Mo	*16:00*	June 17, Mo	*18:31*	June 25, Tu	*19:48*	1193
July 3, We	*05:17*	July 9, Tu	*20:56*	July 17, We	*07:39*	July 25, Th	*11:20*	1194
Aug. 1, Th	*13:12*	Aug. 8, Th	*03:32*	Aug. 15, Th	*22:31*	Aug. 24, Sa	*00:58*	1195
Aug. 30, Fr	*20:38*	Sept. 6, Fr	*13:11*	Sept. 14, Sa	*14:35*	Sept. 22, Su	*12:43*	1196
Sept. 29, Su	*04:27*	Oct. 6, Su	*02:48*	Oct. 14, Mo	*07:10*	Oct. 21, Mo	*22:41*	1197
Oct. 28, Mo	*13:40*	Nov. 4, Mo	*20:23*	Nov. 12, Tu	*23:37*	Nov. 20, We	*07:13*	1198
Nov. 27, We	*01:07*	Dec. 4, We	*16:58*	Dec. 12, Th	*15:14*	Dec. 19, Th	*14:59*	1199
Dec. 26, Th	*15:15*							1200

Use the Moon phases table provided to advise whether this date is ideal or whether there is a date around the time of Sarrita's birthday that is more likely to have calm weather.

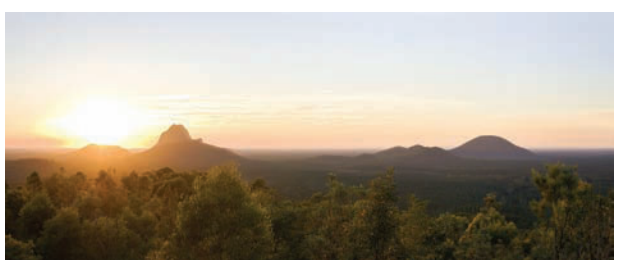
★7 Answer the following with reference to the sunrise/sunset chart shown at right.

2020	Sunrise/Sunset	
Dec	**Sunrise**	**Sunset**
▼ **14**	4:48 am →(117°)	6:36 pm ←(243°)
▼ **15**	4:49 am →(117°)	6:36 pm ←(243°)
▼ **16**	4:49 am →(117°)	6:37 pm ←(243°)
▼ **17**	4:49 am →(117°)	6:38 pm ←(243°)
▼ **18**	4:50 am →(117°)	6:38 pm ←(243°)
▼ **19**	4:50 am →(117°)	6:39 pm ←(243°)
▼ **20**	4:51am →(117°)	6:39 pm ←(243°)
▼ **21**	4:51 am →(117°)	6:40 pm ←(243°)
▼ **22**	4:52 am →(117°)	6:40 pm ←(243°)

a Kieran is going fishing on 17th December. His theory is that the fish are always biting right at the time of sunrise. Determine the time on this day that he will need to be out fishing.

b Casey has put up her Christmas lights on the front of her house. She has set up a timer for the lights to come on once the sun has gone down, as she is not always home in the evenings. At which time should Casey set her timer to ensure that her Christmas lights come on at around sunset?

c Stefan is a pilot who flies a plane that requires VFR (visual flight referencing). This means that he flies in daylight between sunrise and sunset. In the month of December, approximately how many daylight hours per day are available for Stefan to charter this plane?



Sunrise over the Glasshouse mountains, Sunshine Coast, Queensland

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★8 Andrea is studying at university and works casually, running photography courses. The most popular courses are her sunrise and sunset photography courses.

To allow the best opportunity for sunrise and sunset photos, she meets her students on the roof of a tall building 20 minutes before the official sunrise and sunset times.

Sunshine Coast, Queensland

March	Sunrise	Sunset
1	5:41 a.m. → (99°)	6:18 p.m. ← (261°)
2	5:41 a.m. → (99°)	6:17 p.m. ← (262°)
3	5:42 a.m. → (98°)	6:16 p.m. ← (262°)
4	5:42 a.m. → (98°)	6:15 p.m. ← (263°)
5	5:43 a.m. → (97°)	6:14 p.m. ← (263°)
6	5:43 a.m. → (97°)	6:13 p.m. ← (263°)

Use the information in the chart shown to identify:

a the sunrise and sunset times for Andrea to meet her students on 4th March

b the degrees from true north (e.g. 99°) of the sunrise and sunset on 6th March

c the difference in sunrise times between 1st March and 6th March

★9 Answer the following, using the information given in the tidal chart shown.

TODAY 4 Jan	**FRI** 5 Jan	**SAT** 6 Jan	**SUN** 7 Jan	**MON** 8 Jan
▼ 3:57 a.m. 0.39 m	▼ 4:43 a.m. 0.54 m	▼ 5:30 a.m. 0.77 m	▲ 12:24 a.m. 3.05 m	▲ 1:22 a.m. 2.94 m
▲ 10:20 a.m. 4.17 m	▲ 11:08 a.m. 4 m	▲ 11:56 a.m. 3.78 m	▼ 6:21 a.m. 1.03 m	▼ 7:23 a.m. 1.29 m
▼ 5:01 p.m. 0.65 m	▼ 5:48 p.m. 0.74 m	▼ 6:34 p.m. 0.87 m	▲ 12:48 p.m. 3.53 m	▲ 1:45 p.m. 3.31 m
▲ 10:41 p.m. 3.28 m	▲ 11:31 p.m. 3.17 m		▼ 7:21 p.m. 1.01 m	▼ 8:12 p.m. 1.11 m

a Patrick is going crabbing during the low tides on Friday. If the safest times to do this are within 2 hours of low tide, determine the suitable times on this day for Patrick to be on the beach catching crabs.

b On Sunday morning, Kelly and Henry are heading out fishing while on holiday in Hervey Bay. Kelly insists that the best time to fish is the hour before high tide, as it brings the fish with it. Identify a suitable time to recommend for them to head out fishing if they are to follow Kelly's theory.

c On Thursday 4th January, Carlene and Brian left their dinghy tied to the jetty and went exploring the town. When they returned to their dinghy at 5 p.m., they discovered that it was sitting on the sand, as the tide had gone out. If Carlene and Brian must wait a minimum of 3 hours after low tide before it is deep enough to use the dinghy, at what time will it be deep enough so that they can head back home?

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Example 16 ★10 On Wednesday 24th January Damien is taking his family on a 4WD adventure from Noosa to Double Island Point. The trip requires a 1 hour drive on the beach. Upon arriving at Double Island Point, Damien would like to spend as much time as possible there. However, he is mindful of the tides, as he has heard that many people have been caught out on this beach and their vehicles destroyed by the high tide.

Damien is travelling only during daylight and he wishes to be on the beach only within 2 hours either side of the low tide. Remember that he must also allow for the 1 hour of travel time on the beach.

SUN 21 Jan	**MON** 22 Jan	**TUE** 23 Jan	**WED** 24 Jan	**THU** 25 Jan
▼ 3:58 a.m. 0.55 m	▼ 4:36 a.m. 0.63 m	▼ 5:21 a.m. 0.72 m	▲ 12:31 a.m. 1.49 m	▲ 1:45 a.m. 1.53 m
▲ 10:37 a.m. 1.9 m	▲ 11:11 a.m. 1.83 m	▲ 11:49 a.m. 1.75 m	▼ 6:19 a.m. 0.81 m	▼ 7:36 a.m. 0.88 m
▼ 5:05 p.m. 0.63 m	▼ 5:43 p.m. 0.65 m	▼ 6:26 p.m. 0.66 m	▲ 12:36 p.m. 1.67 m	▲ 1:38 p.m. 1.59 m
▲ 10:51 p.m. 1.5 m	▲ 11:36 p.m. 1.49 m		▼ 7:19 p.m. 0.65 m	▼ 8:22 p.m. 0.63 m

For each of the following, use the information given and refer to the tidal chart shown.

a Determine the times that Damien could start driving on the beach to head to Double Island Point.

b Determine the times that he would need to leave Double Island Point to travel safely on the beach.

c Calculate how long Damien and his family could stay at Double Island Point.

The beach from Double Island Point, looking south towards Noosa.

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PROBLEM-SOLVING

★11 A 'rule of thumb' is that after low or high tide, the tide height changes by 25% in the first and second hours, 50% in the third and fourth hours, and 25% in the fifth and sixth hours.

Use this rule of thumb to answer the following questions about the changes in tide height at Hay Point (south of McKay) on 1st February, which are presented in the table.

1 FEBRUARY Hay Point	
Time	**Height (in m)**
05:19	0.38
11:26	7.09
18:02	0.58
23:50	5.81

Find the change in tide height, in metres, to one decimal place:

a from the first low tide to the first high tide
b over the first two hours after the first low tide
c in the third and fourth hour after the first low tide
d in the last two hours before the first high tide
e from the first high tide to the second low tide
f in the third and fourth hour after the first high tide

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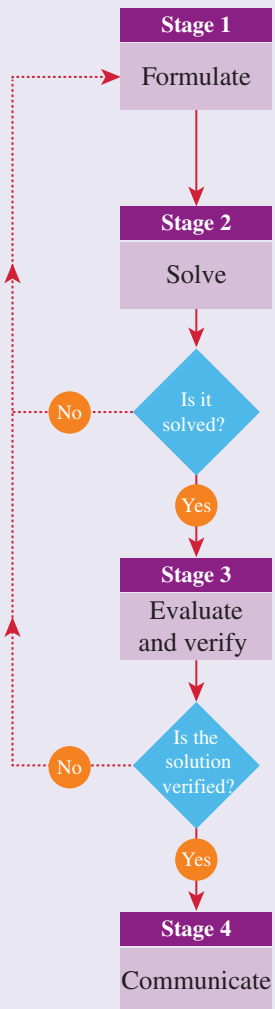
Problem-solving and modelling task

DAY TRIP

Background: Timetables are essential for using public transport, and creating your own personalised timetable is an excellent way to plan a trip and keep to time.
Task: Your task is to plan a day trip around a city near you. You must use at least two forms of public transport during your trip. Make sure you keep a copy of the transports' timetables to show your teacher the departure and arrival times. With this information, create a timetable that details your plan for the day.

To complete this task, follow the problem-solving workflow diagram below and use the steps listed as a guide.



Stage 1: Formulate

1 Decide on the destination city.
2 Research interesting things to do in this city.
3 Look up public modes of transport available.

Stage 2: Solve

4 Decide on at least two destinations or activities that will be completed during the day trip.
5 Look up relevant transportation timetables and use these to identify suitable routes to help plan your movement around the city.
6 Plan your trip and decide on relevant time intervals. Consider where are you starting from? How long does the bus take? How much time would you need at the museum, etc.?

Stage 3: Evaluate and verify

7 Check that you have allowed yourself enough time to complete the activity and then make it to your mode of transport.

Stage 4: Communicate

8 Communicate your findings in the form of a timetable, detailing the activities that took place and the transportation that was used, in an ordered manner. You might like to use this table as a guide.

Time	Activity
8 a.m.	
9 a.m.	
10:30 a.m.	
12 p.m.	
1:15 p.m.	
3 p.m.	

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Puzzle

WHAT IS TIME MANAGEMENT?

Good time management skills are essential in many careers. It enables you to work smarter, meaning you get more done in a shorter space of time – even when time is short and the pressure is mounting. Failing to manage your time well may cause stress and potentially decreases your rate of success. There are three key aspects to becoming skilled in time management. The first two are organisation and planning. To find the third, solve the puzzle below. Copy the chart below into your notebook. Find the answer to each question part in the chart. Write the letter of the question part in the cell above its answer.

1 Calculate the number of hours, in decimal time, for the following time periods.

A 8 a.m. to 1:30 p.m.

B 7 a.m. to 2.15 p.m.

C 12.18 p.m. to 7.32 p.m.

D 4.51 a.m. to 11.29 p.m.

2 Use a suitable calculation to convert the following decimal hours to the form hours : minutes : seconds.

I 3.42 hours

N 7.16 hours

O 2.97 hours

3 Express the following 12-hour times as 24-hour times.

P 3:55 p.m.

R 12:11 a.m.

4 Express the following 24-hour times as 12-hour times.

S 19:22

T 12:30

7.23	2:58:12

7:9:36	2:58:12	12:30 p.m.

15:55	0:11	2:58:12	7.25	0:11	5.5	7:22 p.m.

12:30 p.m.	3:25:12	7:9:36	5.5	12:30 p.m.	6.63

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Chapter checklist

☐ I can use units of time and convert between fractional, decimal and digital times.

1 Yesterday Josef worked for 6 hours and 15 minutes. Write the minutes as a fraction of an hour and use division to simplify, then write how each fractional time is spoken.

2 Last week Rania worked for 32 hours and 27 minutes. Calculate the number of hours that she worked, in decimal form.

☐ I can represent time using 12-hour and 24-hour clocks.

3 Bronwyn has just received a text from her brother in Canada, asking her to call him at Australian time 00:30. What time should she set her 12-hour alarm clock?

4 Oliver is a drill sergeant in the army and he has instructed his troupe to meet him in two and a half hours from now. If the instruction was given at 12:45 p.m., at what time must Oliver's troupe meet again, using 24-hour time?

☐ I can calculate time intervals, including the time between, the time ahead and the time behind.

5 Joel has just finished working from 8:15 a.m. to 2:50 p.m. Calculate the length of his shift.

6 Katrina is driving to Cairns for a holiday. She expects the trip to take 7 h and 45 min. If Katrina leaves home at 5:20 a.m., determine the time that she would expect to arrive.

☐ I can interpret timetables for buses, trains and/or ferries.

7 Tammie must catch a bus from her hotel, which is located in the city centre of Mackay, to the airport. She must be at the airport by 10:30 a.m. Use the following timetable to identify the latest time she could catch the bus from her hotel.

route **303** — **Caneland Central to Mackay Airport**
servicing City, South Mackay and Paget

Monday to Friday												Saturday			
Route number	303	303	303	303	303	303	303	303	303	303	303	303	303	303	303
	am	am	am	am	am	am	pm	pm	pm	pm	pm	am	am	pm	pm
C Caneland Central	6.45	7.45	8.45	9.45	10.45	11.45	1.45	2.45	3.45	4.45	5.45	9.45	11.45	2.45	4.45
C City (Gregory St)	6.49	7.49	8.49	9.49	10.49	11.49	1.49	2.49	3.49	4.49	5.49	9.49	11.49	2.49	4.49
SM South Mackay (Penn St)	6.56	7.56	8.56	9.56	10.56	11.56	1.56	2.56	3.56	4.56	5.56	9.56	11.56	2.56	4.56
SM South Mackay (Dennis St)	7.00	8.00	9.00	10.00	11.00	12.00	2.00	3.00	4.00	5.00	6.00	10.00	12.00	3.00	5.00
SM South Mackay (Napier St)	7.07	8.07	9.07	10.07	11.07	12.07	2.07	3.07	4.07	5.07	6.07	10.07	12.07	3.07	5.07
A Mackay Airport	7.11	8.11	9.11	10.11	11.11	12.11	2.11	3.11	4.11	5.11	6.11	10.11	12.11	3.11	5.11

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I can use timetables and/or electronic technologies to plan and compare the most time-efficient routes.

8 Shae lives in Maroochydore and studies full-time at the University of the Sunshine Coast (USC). She catches a bus four mornings a week and must be on campus by 10:30 a.m. to attend lectures. Shae has two options.

Option 1: Travel with her housemate to Mooloolaba by 9:45 a.m. every morning and then catch a bus from there.

Option 2: Catch a bus directly from Maroochydore to USC.

Use the following two bus timetables to determine the best route for Shae if she wishes to spend the least amount of time travelling to university.

Image provided courtesy of TransLink, Department of Transport and Main Roads (Effective, August 2018).

Route 615 — Maroochydore to Landsborough via University
servicing Maroochydore, Mooloolaba, University and Landsborough

Monday to Friday

Route number	615	615	615	615	615	615	615	615	615	615	615	615	615	615	615	615	615	615	615
	am	am	am	am	am	am	am	am	am	pm	pm	pm	pm	pm	pm	pm	pm	pm	pm
J Maroochydore station (P1)	5.00	5.30	5.55	6.11	6.32	6.59	8.41	10.01	11.41	1.11	2.07	2.35	3.53	4.35	5.10	5.25	6.40	7.05	9.13
I Alexandra Headland Beach	5.05	5.35	6.00	6.16	6.37	7.04	8.46	10.06	11.46	1.16	2.12	2.40	3.58	4.40	5.15	5.30	6.45	7.10	9.18
H Mooloolaba, River Esp	5.10	5.40	6.05	6.21	6.42	7.09	8.51	10.11	11.51	1.21	2.17	2.45	4.03	4.45	5.20	5.35	6.50	7.15	9.23
G USC station (P1)	5.25	5.55	6.20	6.36	6.57	7.24	9.06	10.26	12.06	1.36	2.32	3.00	4.18	5.00	5.35	5.50	7.05	7.30	9.38
F Chancellor Park Marketplace	5.27	5.57	6.22	6.38	6.59	7.26	9.08	10.28	12.08	1.38	2.34	3.02	4.20	5.02	5.37	5.52	7.07	7.32	9.40
E Aussie World	-	-	-	-	-	-	-	10.33	-	-	-	-	4.25	-	-	-	-	-	-
C Mooloolah Cemetery	5.32	6.02	6.27	6.43	7.04	7.31	9.13	10.43	12.13	1.43	2.39	3.07	4.35	5.07	5.42	5.57	7.12	7.37	9.45
D Landsborough station	5.45	6.15	6.40	6.56	7.17	7.44	9.26	10.56	12.26	1.56	2.52	3.26	4.48	5.20	5.55	6.10	7.25	7.50	9.58
B	*For real-time connecting train services, please download the **My TransLink** app, visit **translink.com.au** or call **13 12 30**.*																		
K Australia Zoo	-	-	-	-	-	-	9.36	11.06	-	-	-	-	-	-	-	-	-	-	-

Route 616 — Maroochydore to University via Alexandra Headland
servicing Maroochydore, Alexandra Headland, Buderim and University

Monday to Friday

Route number	616	616	616	616	616	616	616	616	616	616	616	616	616	616	616	616	616	616	616	616
	am	am	am	am	am	am	am	am	am	am	am	pm	pm	pm	pm	pm	pm	pm	pm	pm
A Maroochydore station (PL1)	6.55	7.25	7.55	8.25	8.55	9.25	9.55	10.25	10.55	11.25	11.55	12.25	12.55	1.25	1.55	2.25	2.55	3.25	3.55	4.25
B Alexandra Headland Beach	7.00	7.30	8.00	8.30	9.00	9.30	10.00	10.30	11.00	11.30	12.00	12.30	1.00	1.30	2.00	2.30	3.00	3.30	4.00	4.30
C Alexandra Headland, Janet St	7.05	7.35	8.05	8.35	9.05	9.35	10.05	10.35	11.05	11.35	12.05	12.35	1.05	1.35	2.05	2.35	3.05	3.35	4.05	4.35
D Buderim Gardens Retirement Village	7.10	7.40	8.10	8.40	9.10	9.40	10.10	10.40	11.10	11.40	12.10	12.40	1.10	1.40	2.10	2.40	3.10	3.40	4.10	4.40
E Buderim Mountain State School	7.15	7.45	8.15	8.45	9.15	9.45	10.15	10.45	11.15	11.45	12.15	12.45	1.15	1.45	2.15	2.45	3.15	3.45	4.15	4.45
F USC station	7.25	7.55	8.30	8.55	9.25	9.55	10.25	10.55	11.25	11.55	12.25	12.55	1.25	1.55	2.25	2.55	3.30	3.55	4.25	4.55

I can interpret complex timetables such as tide charts, moon phases and sunrise/sunset charts. [Complex]

9 Aaron wishes to find the earliest time to catch the 20 min ferry trip to Fraser Island on Wednesday morning 7th February. The ferry also transports vehicles to the island. Upon arrival, Aaron will need to drive along the beach to get to his destination. As beach travel is safe only within 2 hours of low tide, determine the earliest time he can catch the ferry.

TUE 6 Feb	**WED** 7 Feb	**THU** 8 Feb
▲ 12:53 a.m. 3.08 m	▲ 1:51 a.m. 2.95 m	▲ 3:06 a.m. 2.88 m
▼ 7:03 a.m. 1.3 m	▼ 8:11 a.m. 1.55 m	▼ 9:40 a.m. 1.67 m
▲ 1:10 p.m. 3.2 m	▲ 2:08 p.m. 2.95 m	▲ 3:16 p.m. 2.79 m
▼ 7:36 p.m. 1.15 m	▼ 0:31 p.m. 1.28 m	▼ 9:37 p.m. 1.35 m

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Chapter Review

All questions in the Chapter Review are assessment-style.

Simple Familiar

Section 10A

1 Michael works full-time at a discount store. His roster is in 24-hour time and he is working tomorrow from 11:00 to 19:45. Express Michael's start and finishing times in 12-hour time.

2 Anita ran a 10 km marathon in 1:05:39 h. Express this time in decimal form.

Section 10B

3 Dimitri's payslip states that he worked for 28.8 h this past week. Dimitri had recorded that he has worked for 28 h and 45 min. Determine if Dimitri's payslip is correct. Justify your answer with mathematical working and discuss how Dimitri's boss could have concluded that this was correct.

4 Joan is booked in for an x-ray on her knee. She is told that the scan will take around 12 min. She looks at the time on her way into the room and it is 1:09 p.m.

a Determine the time when Joan would expect her x-ray to be completed.

b Express the expected finishing time in 24-hour time.

5 Justine went to her local public library at 9:15 a.m. and returned home at 12:02 p.m. Determine how long she was out, in hours and minutes.

6 Kyosti has just finished his English lesson. All lessons go for 80 min and the time is now 2:56 p.m. At what time did Kyosti's lesson begin?

Section 10C

7 Use the information in the Brisbane train timetable shown to answer the following.

Monday to Thursday (continued)

Comes from	BNH	RSW	MNY	SFC	VYS	IPS	CVN	SFC	VYS	IPS	BNH
Station	am	am	am	am	am	am	am	am	am	am	am
Park Road	**7:27**		**7:29**		**7:32**		**7:37**		**7:39**		**7:42**
South Bank	7:30		7:32		7:35		7:40		7:42		7:45
South Brisbane	7:32	----	7:34	----	7:37	----	7:42	----	7:44	----	7:47
Roma Street	7:37	7:39	7:39	7:42	7:42	7:45	7:47	7:48	7:49	7:51	7:52
Central arrive	**7:39**	**7:41**	**7:41**	**7:44**	**7:44**	**7:47**	**7:49**	**7:50**	**7:51**	**7:53**	**7:54**
Central depart	**7:41**	**7:43**	**7:43**	**7:46**	**7:46**	**7:49**	**7:51**	**7:52**	**7:53**	**7:55**	**7:56**
Fortitude Valley	7:43	7:45	7:45	7:48	7:48	7:51	7:53	7:54	7:55	7:57	7:58
Bowen Hills	7:46	7:47	7:48	7:50	7:51	7:53	7:56	7:56	7:58	7:59	8:01
Albion	----	----	7:52	----	7:55	----	----	exp	8:02	----	----
Wooloowin			7:54		7:57			exp	8:04		
Eagle Junction			**7:56**		**7:59**			**8:01**	**8:06**		
Toombul			7:58		----			exp	----		
Nundah			8:00					exp			
Northgate			**8:02**					**8:05**			
Continues to	FYG		SHC		BDT			KPR	DBN		FYG

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a Mike is catching the 7:45 train from Roma Street to Fortitude Valley. Calculate how long this train trip would take.

b i Paul is travelling from Roma Street Station to Wooloowin Station. He looks at his watch and catches what he believes to be the 7:49 a.m. train. At what time would he expect to arrive at his destination?

ii Paul has just realised that his watch is 1 minute ahead of time and he has actually caught the 7:48 a.m. train. Paul has caught the express train that does not stop at Wooloowin, so he will need to hop off at Eagle Junction and catch a train back to Wooloowin. Use the following timetable, which shows the trains Paul could catch to return to Wooloowin, to determine the time when he should arrive at his destination.

Monday to Thursday (continued)

Comes from Station	SHC am	FYG am	CAB am	NBR am	FYG am	KPR am	BDT am	CAB am	KPR am	FYG am	DBN am	am	KPR am	FYG am	NBR am	BDT am	SHC am	FYG am
Northgate	**7:42**		**7:49**	**7:54**		**7:57**		**8:00**	**8:03**			**8:04**	**8:09**		**8:12**		**8:12**	
Nundah	7:44		7:51	exp		exp		exp	exp			8:06	exp		exp		8:14	
Toombul	7:46		7:53	exp		exp	----	exp	exp		----	8:08	exp		exp	----	8:16	
Eagle Junction	**7:48**		**7:55**	**7:58**		**8:01**	**8:00**	**8:04**	**8:07**		**8:08**	**8:10**	**8:13**		**8:16**	**8:15**	**8:18**	
Wooloowin	7:50		7:57	exp		exp	8:02	exp	exp		8:10	8:12	exp		exp	8:17	8:20	
Albion	7:52	----	7:59	exp	----	exp	8:04	exp	exp	----	8:12	8:14	exp	----	exp	8:19	8:22	----
Bowen Hills	7:56	7:58	8:03	8:04	8:06	8:07	8:08	8:11	8:13	8:13	8:16	8:18	8:19	8:21	8:22	8:23	8:26	8:28
Fortitude Valley	7:58	8:00	8:05	8:06	8:08	8:09	8:10	8:13	8:15	8:15	8:18	8:20	8:21	8:23	8:24	8:25	8:28	8:30
Central arrive	**8:01**	**8:03**	**8:07**	**8:08**	**8:11**	**8:11**	**8:13**	**8:16**	**8:17**	**8:18**	**8:21**	**8:23**	**8:23**	**8:26**	**8:26**	**8:28**	**8:31**	**8:33**
Central depart	**8:02**	**8:04**	**8:09**	**8:10**	**8:12**	**8:13**	**8:14**	**8:17**	**8:19**	**8:19**	**8:22**	**8:24**	**8:25**	**8:27**	**8:28**	**8:29**	**8:32**	**8:34**
Roma Street	8:05	8:07	8:11	8:12	8:15	8:15	8:17	8:20	8:21	8:22	8:25	8:27	8:27	8:30	8:30	8:32	8:35	8:37
South Brisbane	8:10	8:12	----	----	8:20	----	8:22	8:25	----	8:27	----	8:32	----	----	----	8:37	8:40	8:42
South Bank	8:12	8:14			8:22		8:24	8:27		8:29		8:34				8:39	8:42	8:44
Park Road	**8:15**	**8:17**			**8:25**		**8:27**	**8:30**		**8:32**		**8:37**				**8:42**	**8:45**	**8:47**
Continues to	CNQ	BNH				SFC		CVN		CEP					IPS	VYS	CNQ	BNH

Image provided courtesy of TransLink, Department of Transport and Main Roads (Effective, August 2018).

c Jacquie lives in Bowen Hills and is catching the train to a big furniture sale in Northgate. She would like to be there by 8:15 a.m. so that she can grab some good bargains. Decide which train you would recommend Jacquie should catch.

d David is meeting a friend at 8 a.m. at a café that is a 5 minute walk from the Toombul train station. Considering that he is leaving from Central Station, decide which train would be best for David to catch.

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Section 10D

8 On Friday 6th April, Luke and his family are heading to Stradbroke Island for a 4WD beach driving adventure, returning Monday morning.

a Use the table to identify the low tide times on Friday and Monday.

b It is safe to drive on the beach only within 2 hours either side of low tide. Determine the safe times to drive on the beach on Friday and Monday.

FRI 6 Apr	**SAT** 7 Apr	**SUN** 8 Apr	**MON** 9 Apr	**TUE** 10 Apr
▼ 6:04 a.m. 0.83 m	▲ 12:21 a.m. 2.08 m	▲ 1:18 a.m. 2 m	▲ 2:33 a.m. 1.96 m	▲ 3:47 a.m. 2 m
▲ 11:42 a.m. 1.72 m	▼ 6:58 a.m. 0.91 m	▼ 8:13 a.m. 0.94 m	▼ 9:33 a.m. 0.9 m	▼ 10:37 a.m. 0.81 m
▼ 5:41 p.m. 0.72 m	▲ 12:34 p.m. 1.6 m	▲ 1:48 p.m. 1.54 m	▲ 3:17 p.m. 1.57 m	▲ 4:26 p.m. 1.69 m
	▼ 6:29 p.m. 0.83 m	▼ 7:35 p.m. 0.91 m	▼ 8:58 p.m. 0.92 m	▼ 10:15 p.m. 0.85 m

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11 Distance

Maths for a postal delivery worker: Craig Freeman

Tell us a bit about your job. What does a typical day look like?

I start work at 6 a.m. and sort mail into a V-sort frame. Once the mail is sorted, we check the mail for any redirected mail. We then bundle the mail, ready for delivery. I deliver the mail on a motorbike on a special route. The way that the routes are mainly worked out is based on mostly turning left.

What do you like about being a postie?

Once I am out riding on the road, I am my own boss. I enjoy not having to deal with people directly when I am on my own, especially when the weather is good.

What maths did you study at school?

I studied Maths in Society during Year 12.

How do you use maths in your job?

I use numbers constantly to identify mail when sorting. I am paid an hourly rate and can also get overtime, and my knowledge of maths helps me to check the figures on my payslip each fortnight. The distance we travel is fairly constant, as we travel a set route while delivering the mail.

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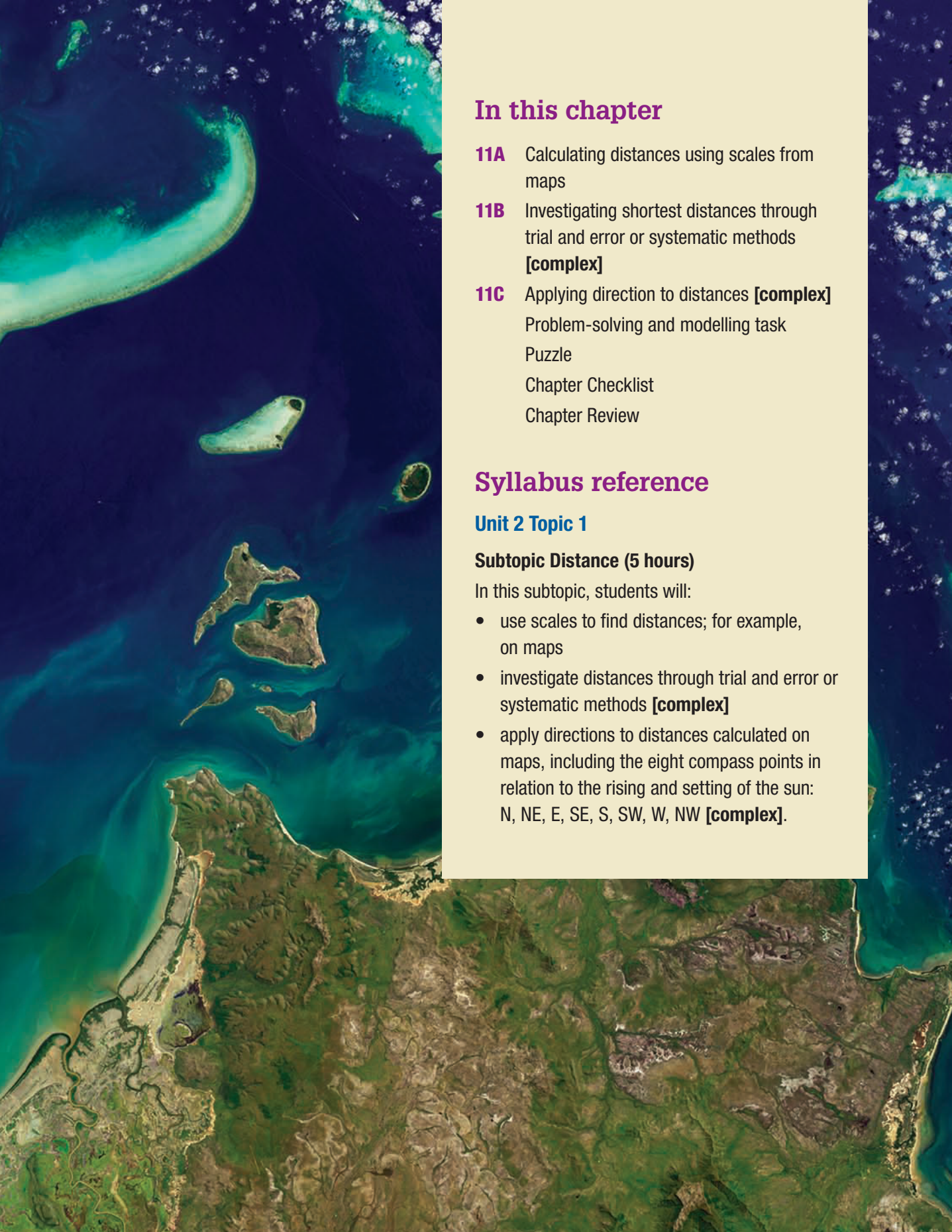

In this chapter

11A Calculating distances using scales from maps

11B Investigating shortest distances through trial and error or systematic methods **[complex]**

11C Applying direction to distances **[complex]**

Problem-solving and modelling task

Puzzle

Chapter Checklist

Chapter Review

Syllabus reference

Unit 2 Topic 1

Subtopic Distance (5 hours)

In this subtopic, students will:

- use scales to find distances; for example, on maps
- investigate distances through trial and error or systematic methods **[complex]**
- apply directions to distances calculated on maps, including the eight compass points in relation to the rising and setting of the sun: N, NE, E, SE, S, SW, W, NW **[complex]**.

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Pre-test

1 Convert the following distances to metres.
- **a** 1 km
- **b** 2.35 km
- **c** 75 mm

2 Convert the following to kilometres.
- **a** 3000 m
- **b** 575 000 cm
- **c** 250 m

3 Calculate the distance covered in 2 h and 30 min when travelling at the following speeds. (Write your answers in km.)
- **a** 60 km/h
- **b** 45 000 m/h
- **c** 300 m/min
- **d** 13 m/s
- **e** 792 m/h
- **f** 33 mm/s

4 Enlarge the following distances to triple the original length. Write each answer in metres.
- **a** 376 m
- **b** 3.75 km
- **c** 355 mm

5 An arrow is currently pointing in an upwards direction. In which direction is the arrow pointing after it is rotated *clockwise* by:
- **a** 90°
- **b** 270°
- **c** 720°

A link to a HOTmaths lesson is provided in the Interactive Textbook to revise this topic.

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11A Calculating distances using scales from maps

LEARNING GOALS

- Revise how to convert a scale distance to an actual distance, using a scale ratio
- Convert a map distance to an actual distance, using the line segment scale given on a map

When would it be essential to calculate distances from maps?

When travelling where the internet is unavailable, it is certainly essential to interpret maps. There are many Australian regions without internet access, where people such as pilots (e.g. Flying Doctors and farmers), truck drivers, tourists, army personnel, workers (e.g. road, railway, electricity) and explorers (e.g. geologists) all find map reading skills essential.

You can use a map scale to calculate actual distances from the map, and so work out how long it will take to travel between various places along a route.

Adventurers must be able to calculate distances using national park maps, orienteering maps and topographical maps.

Geologists drill for rock samples in Australia's outback, where traditional map skills are essential.

WHAT YOU NEED TO KNOW

- **Actual distance** is distance measured on the ground, usually in kilometres. **Map distance** is distance measured on the map with a ruler, usually in centimetres or millimetres.
- The **scale** ratio on a map shows the ratio of map distance to actual distance.

  Scale ratio = map distance : actual distance

- A scale ratio of 1 : 20 000 means the actual distances are 20 000 times longer than the distances measured on a map.
  - For example: Finding the actual distance for a map distance of 4 cm.

    Actual distance $= 4 \text{ cm} \times 20\,000$
    $= 80\,000 \text{ cm}$
    $= 800 \text{ m}$

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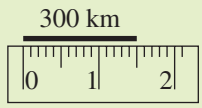
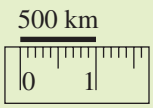
- Many maps include a **line segment scale** instead of a scale ratio. The scale for such maps is determined by first measuring the length of the line segment with a ruler, then calculating the scale.
  - For example: A line segment labelled as 300 km is found to be 15 mm long.
    The line segment scale is 300 km ÷ 15 mm = 20 km/mm.

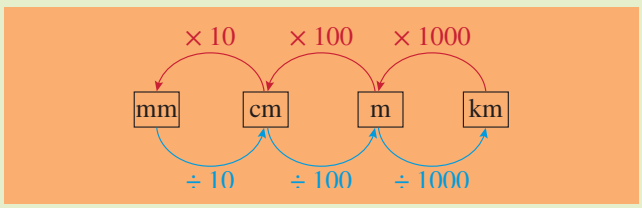


- To calculate actual distances using a map's labelled line segment scale:
  1. Measure the length of the line segment length and calculate the line segment scale by the method described above.
  2. Measure the map distance with a ruler.
  3. Actual distance = map distance × scale
     - For example: Using the line segment scale below, find the actual distance for a 45 mm map distance.



Line segment = 500 km per 10 mm
Scale = 50 km/mm
Map distance = 45 mm
Actual distance = 45 mm × 50 km/mm
= 2250 km

- Conversion of **length units**



Example 1 Convert a scale distance to an actual distance, using a scale ratio

A map has a scale of 1 : 25 000.
Find the actual distance for each of the following scaled distances.

a 130 mm **b** 24.8 cm

WORKING	THINKING
a Actual distance = 130 mm × 25 000 = 3 250 000 mm = 3250 m = 3.25 km	Multiply 130 mm by the scale factor of 25 000, giving an answer in mm. Now convert mm to m and then to km. [mm (÷1000) → m (÷1000) → km]
b Actual distance = 24.8 cm × 25 000 = 620 000 cm = 6200 m = 6.2 km	Multiply 24.8 cm by the scale factor 25 000 to give an answer in cm. Now convert cm to m and then to km. [cm (÷100) → m (÷1000) → km]

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Example 2 Convert a map distance to an actual distance, using the line segment scale given on a map

Using the map of New Zealand shown:

a Measure the line segment scale in mm and calculate the scale in km/mm, to one decimal place.

b Measure directly on the map the distance in mm between Auckland and Invercargill, and then convert this map distance to the actual distance, to the nearest 10 km.

WORKING	THINKING
a Line segment = 200 km per 11 mm Scale = 18.2 km/mm	Measure the line segment in mm. Calculate km/mm, rounding to one decimal place.
b Map distance = 65 mm Actual distance = 65 mm × 18.2 km/mm = 1180 km	Measure directly on the map the distance in mm between Auckland and Invercargill. Actual distance = map distance in mm × km/mm

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Exercise 11A

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words and units.

a The scale ratio on a map shows the ratio of _____ length : _____ length.

b A scale ratio of 1 : 5000 shows actual lengths are 5000 times _____ than the ____ lengths.

c Many maps include a line _____ scale instead of a scale ratio.

d To calculate actual distances using a map's line segment scale:

1 Measure the ____ segment scale in ___.

2 Calculate km/___ from the line segment scale.

3 The _____ distance in km = ____ distance in __ × scale in __/__.

Example 1

2 Find the actual distance for each of the scaled distances. Give your answer in appropriate units.

Hint Multiplying by the scale factor does not change the units.

a scale 1 : 1000

i 6 cm **ii** 120 mm

b scale 1 : 20 000

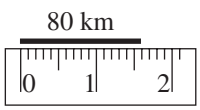
i 4 cm **ii** 300 mm

c scale 1 : 8000

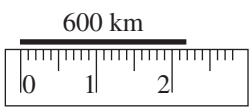
i 13 mm **ii** 3.75 cm

3 Each of the following line segment scales has a ruler in cm and mm shown with it. Write the length of each line segment, to the nearest mm, and find each scale in km/mm. Give your answers to one decimal place.

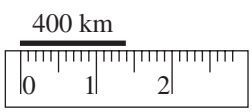
a



b



c



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Example 2

4 Using the map of Queensland shown:

a Measure the line segment scale in mm and calculate the scale in km/mm, to one decimal place.

b Between each two places listed below, first measure in mm the distance directly on the map and then convert each map distance to the actual distance, to the nearest 10 km.

i Mt Isa and Brisbane

ii Rockhampton and Longreach

iii Toowoomba and Weipa

iv Mt Isa and Cairns

5 Camooweal is the last town in Queensland when driving to the Northern Territory. Use the scale given on the map below to determine the distance, in km, that Camooweal is from the Northern Territory border. Round your answer to the nearest km.

Hint First calculate the scale in km/mm, to one decimal place.

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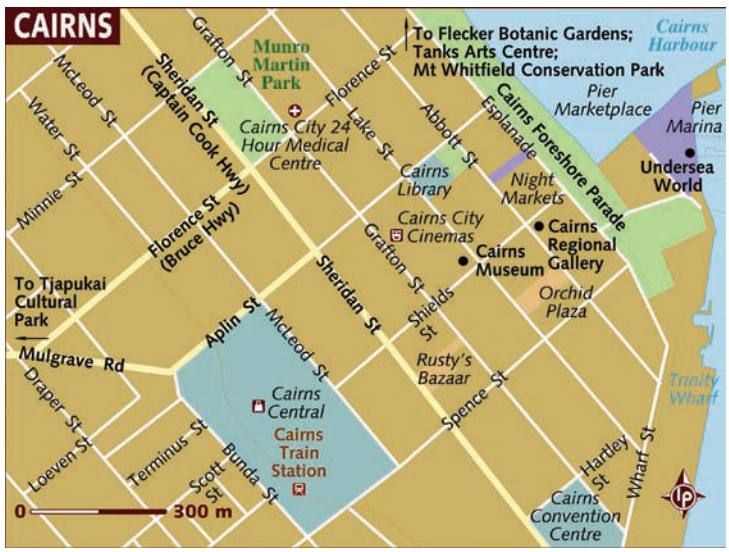
6 Using this map of Cairns and its given scale, find the approximate driving distance between the following places.



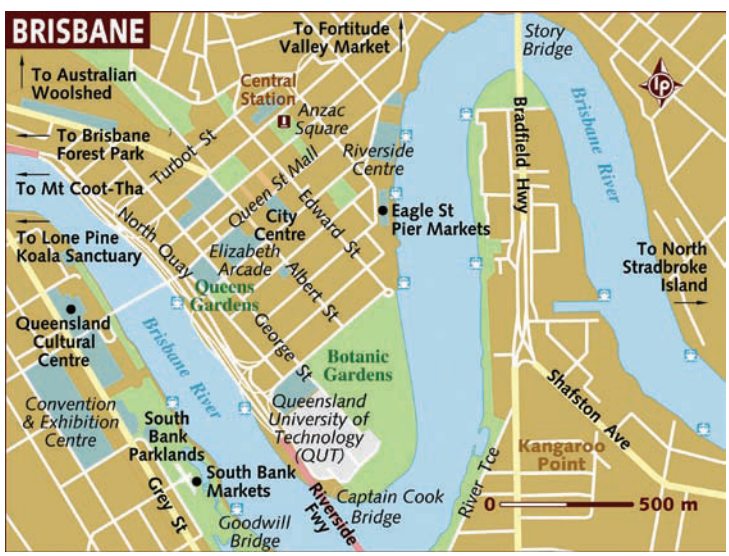
a Cairns Museum to Undersea World

b Cairns Convention Centre to Cairns City Cinemas

c Cairns 24-hour Medical Centre to Cairns Regional Gallery

Hint A driving distance means that you measure along the roads.

7 Using this map of Brisbane and its given scale, find the approximate driving distance between the places listed.



a Central Station to Eagle St, Pier Markets

b Queensland Cultural Centre to South Bank Markets

c South Bank Markets to QUT

Hint First calculate the scale in km/mm, to one decimal place.

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APPLICATIONS

SF: 8–12	CF: –	CU: –

8 The map below shows the Birdsville Track, which was developed in the late 1800s as part of the stock route for walking cattle from North Queensland to a railway station at Marree, South Australia.

Use this map and its given scale to calculate the following direct distances.

a Birdsville to Innaminka

b Mungeranie to Ettadunna

c Marree to Cameron Corner (where the State borders of SA, Qld and NSW meet)

Mungeranie Springs. Map skills are used when estimating the travel time between the artesian springs on the Birdsville Track.

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9 Archie is looking at this map of Australia. He believes that the largest distance between any two towns in Australia is either between Exmouth and Noosa Heads or Hobart and Darwin. Calculate both approximate distances and determine which is the larger distance and by how many km.

10 The Queen Street Mall in Brisbane runs from George Street to Edward Street and it is 12 m wide. The Brisbane City Council wish to resurface the Mall at a cost of $\$272/m^2$. Use the map from Question **7** to determine the approximate length of the Queen Street Mall and then calculate the approximate cost of resurfacing it.

11 Brisbane has a ferry system along the Brisbane River. On the Brisbane city map given in Question **7**, the ferry stops are marked with boat symbols. For travel from the Riverside Centre to the South Bank Parklands, calculate:

a the approximate distance, both in metres and km

b the approximate time taken for this trip, given that the ferry averages 10 km/h. (Time = distance ÷ speed)

The Brisbane River Code of Conduct provides navigation and boating guidelines.

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12 Saanvi is visiting Cairns and is staying in an apartment on the corner of Sheridan Street and Spence Street. She is meeting her friend Aanya at Undersea World at 2 p.m.

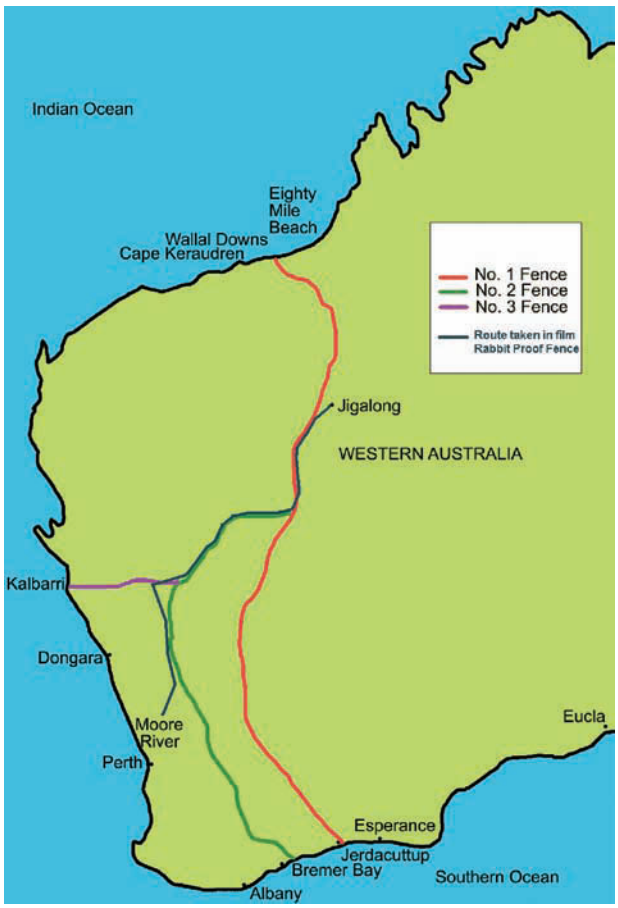
a Using the Cairns city map shown in Question **6** and its scale, determine the approximate distance between Saanvi's accommodation and Undersea World.

b If Saanvi walks at approximately 50 m per minute, at what time should she leave to meet Aanya at the arranged time?

PROBLEM-SOLVING

13 This map of Western Australia shows the three rabbit-proof fences that were constructed in the early 1900s.

The red line is the Number 1 fence that crosses WA from south to north. When Number 1 fence was completed in 1907, it was the longest unbroken fence in the world.



a Given that the direct distance from Esperance to Perth is 600 km, calculate the map's scale in km/mm.

b Using a length of cotton or string to assist you, determine the length of Number 1 fence, to the nearest 10 km.

In the 1880s, fences against rabbits and other vermin had been built in South Australia and Queensland. In the 1940s some of these were used as the basis for a Dingo fence. The Dingo fence measures 5614 km from Queensland to South Australia and is now regarded as the longest unbroken fence in the world.

The Dingo fence at the Queensland border. It is still maintained along its full 5614 km length.

c By what percentage is the length of the Dingo fence greater than the length of the Number 1 rabbit-proof fence in WA?

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11B Investigating shortest distances through trial and error or systematic methods COMPLEX

LEARNING GOALS

- Use trial and error to determine the shortest route between two places
- Use a systematic method to determine the shortest route between several places

When is it essential to calculate the shortest route from maps?

The shortest distance between any network of locations will typically be the fastest and most economical route. Shortest distance routes are calculated for road networks, rail networks, electricity networks, water supply networks, airline flight paths and communication networks.

Even small local networks find the shortest distance for a route, such as for a parcel delivery route and for a community nurse to visit several of her patients in a country area or across various suburbs.

Delivery companies calculate the shortest possible route for an economical and efficient service.

WHAT YOU NEED TO KNOW

- The shortest route is the route that has the smallest total distance.
- The shortest route can be calculated in two ways:
  - **Trial and error**: distances are calculated for each route and compared.
  - **Systematically**: the shortest distance is selected from each point on the route to the next.
- The scale on a map can be expressed in two ways:
  - As a **scale ratio**; for example, map distance : actual distance = 1 : 5000.
  - As a **line segment scale**; for example, $\frac{400 \text{ km}}{}$.
- To calculate actual distances using a map's labelled line segment scale:
  1. Measure the length of the line segment length and calculate the line segment scale by the method described above.
  2. Measure the map distance with a ruler.
  3. Actual distance = map distance $\times$ scale

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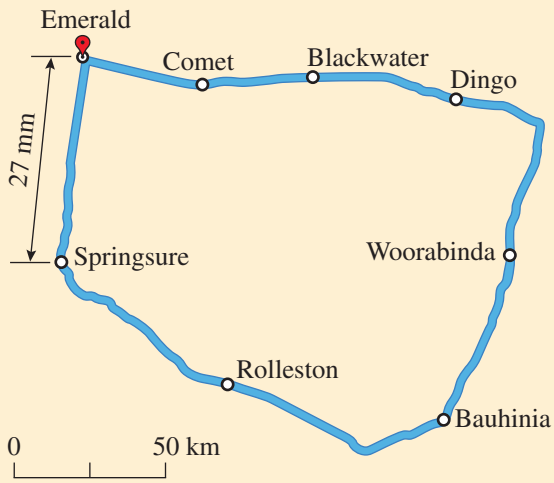
Example 3 Use trial and error to determine the shortest route between two towns

Determine the shortest road distance, in km, from Emerald to Woorabinda, via Rolleston, or via Dingo.



WORKING	THINKING
Line segment = 50 km per 20 mm Scale = 2.5 km/mm	First calculate the scale ratio of the map. The line segment scale is 20 mm in length. For every mm on the map, the real-life distance is $\frac{50}{20}$ = 2.5 km/mm.
Emerald to Woorabinda via Rolleston: Map distance = 110 mm Actual distance = 110 mm × 2.5 km/mm = 275 km	The approximate map distance is 110 mm, so multiply by 2.5 km/mm.
Emerald to Woorabinda via Dingo: Map distance = 80 mm Actual distance = 80 mm × 2.5 km/mm = 200 km	The approximate map distance is 80 mm, so multiply by 2.5 km/mm.
The trip via Dingo is 75 km shorter.	Write your answer as a sentence.

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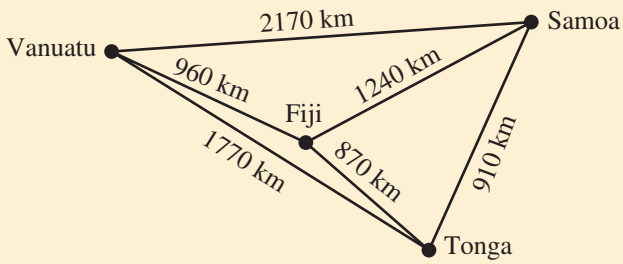
Example 4 Systematically calculate the shortest route between several places

Tevita Transport delivers cargo by plane throughout the Pacific Islands. Its home base is in Fiji.
Using the distances in the diagram, systematically calculate the shortest route, starting from Fiji and flying to Samoa, Vanuatu and Tonga in any order, and returning to Fiji.



The diagram is not to scale.

WORKING	THINKING
Shortest distances between islands: Fiji to Tonga (870 km) Tonga to Samoa (910 km) Samoa to Vanuatu (2170 km) Vanuatu to Fiji (960 km)	List the islands in pairs with each connecting distance and calculate the overall shortest distance. The shortest flight from Fiji is 870 km to Tonga, and the shortest flight from Tonga is 910 km to Samoa. Vanuatu is the only island left to connect, being 2170 km from Samoa, then a 960 km return flight to Fiji.
Shortest distance: $= 870 + 910 + 2170 + 960$ $= 4910$ km	Add the distances to find the shortest distance overall.

Exercise 11B

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words and units.

a The scale on a map can be expressed in two ways:

i As a _____ _____, which is _____ length : _____ length.

ii As a line _____ scale.

b The steps to calculate actual distances using a map's line segment scale are:

1 Measure the line _____ in mm.

2 Calculate __/___ from the line segment scale.

3 Actual distance in km = ____ distance in units of __ × scale in __/__.

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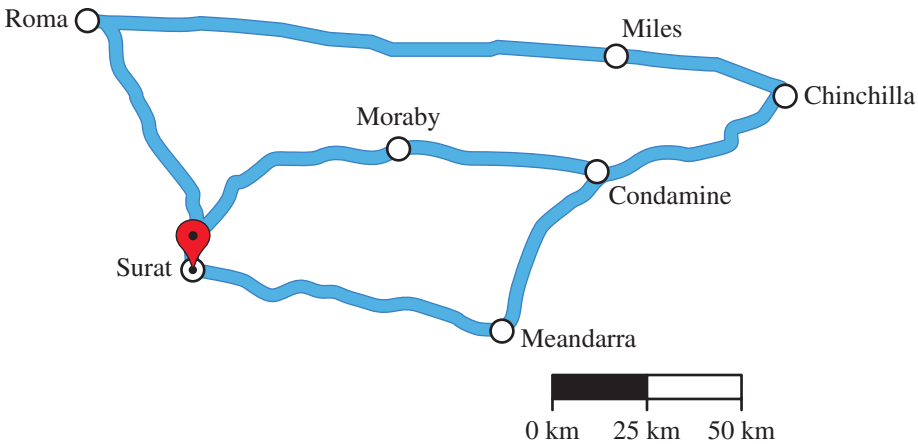
Example 3

2 Charlie is driving his cattle truck from Chinchilla to Saint George and would like to know the shortest route to take. Use this map to answer the following questions.



a Apply your knowledge of scale to the map, to calculate and compare the approximate lengths of these three possible routes for Charlie's cattle truck. (Answer may vary depending on the accuracy of measurement)

i Chinchilla to Surat via Roma

ii Chinchilla to Surat via Codamine and Moraby

iii Chinchilla to Surat via Condamine and Meandarra

b Advise Charlie of the shortest route to take and its length.

APPLICATIONS

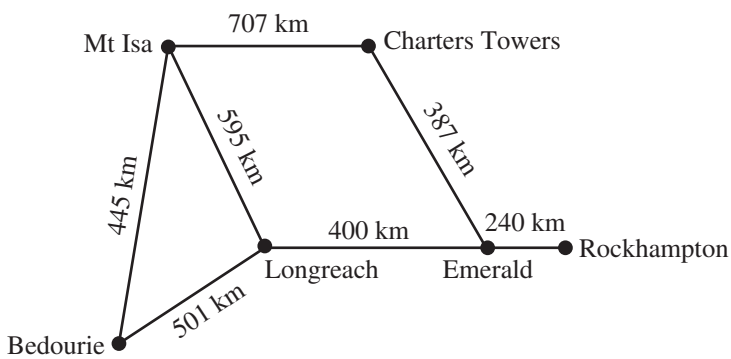
SF: –	CF: 3–6	CU: 7

Example 4

3 Parcel Planes fly out from Rockhampton and deliver lightweight freight to western Queensland towns. Today they must deliver supplies to Emerald, Longreach, Bedourie, Mt Isa and Charters Towers.

Given the sketch below, systematically calculate the shortest route for Parcel Planes to deliver supplies to all these towns, starting from and returning to Rockhampton.

List the cities in pairs with each connecting distance and calculate the overall shortest distance.



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4 Daisy Delivery Service flies parcels from Sydney to three regional centres in New South Wales: Dubbo, Tamworth and Bourke.

a Find the total distance to travel from Sydney to Tamworth to Dubbo to Bourke and back to Sydney.

b Find the total distance to travel from Sydney to Tamworth to Bourke to Dubbo and back to Sydney.

c Compare the two routes and determine the shortest route for the Daisy Delivery Service.

Hint First measure the line segment scale and calculate km/mm.

★5 Jack is a young pilot who has a contract to operate a mail delivery service by plane in the Gulf area of North Queensland, shown in the map on the next page. Jack will deliver mail to Doomadgee, Gregory Downs, Burketown, Karumba, Normanton, Croydon and the Burke and Wills Roadhouse. He must decide whether to base the business at Julia Creek or Mt Isa.

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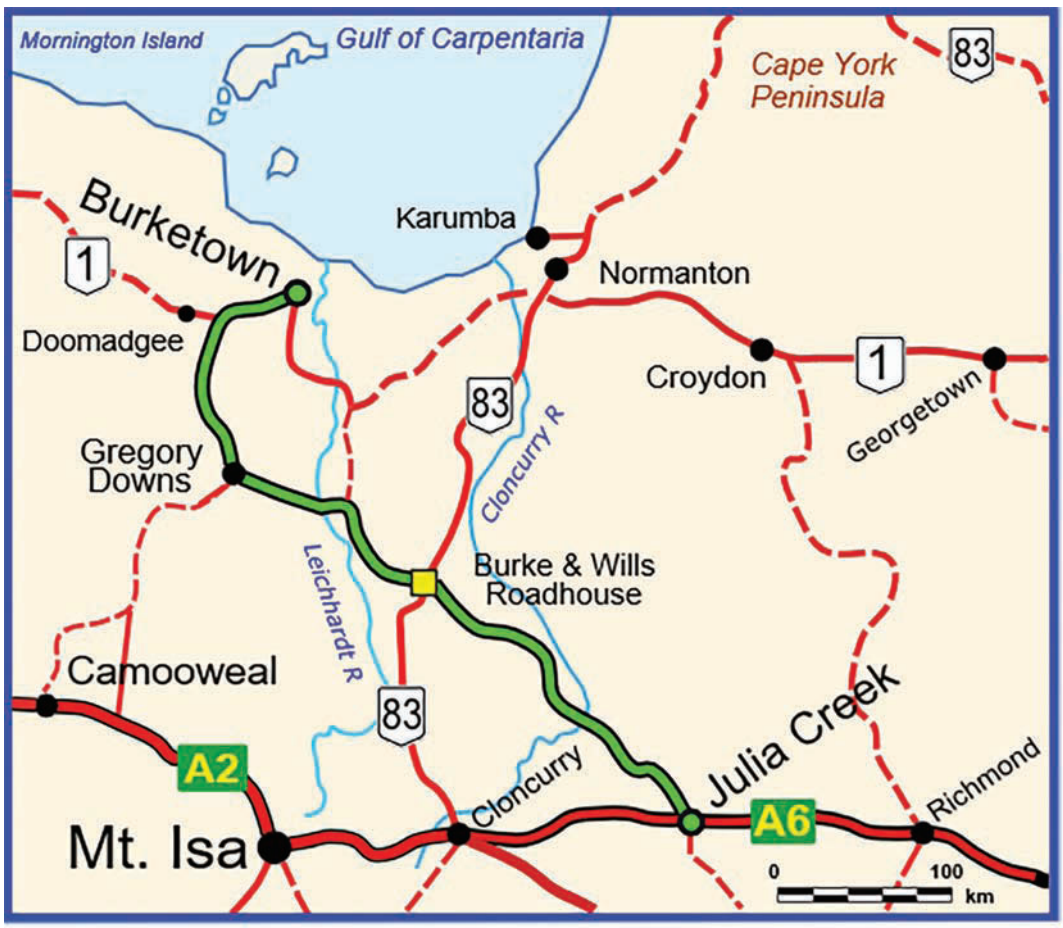
a Use systematic methods to determine the shortest route and its length when starting and finishing at:
- **i** Mt Isa
- **ii** Julia Creek

b Which is the most suitable town for Jack's home base?



★**6** Angela and Deon are holidaying in Egypt. They decide to visit the following localities, starting and finishing their holiday in Cairo: Alexandria, Minya, Beni-Suef, Dakhla Oasis, Sohag and Port Said.
Use a systematic method to determine the shortest route and its total distance for Angela and Deon

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to visit all the places on their list. Calculate direct distances between towns, to simplify the solution.

PROBLEM-SOLVING

XLS

7 Donna's Deliveries is a start-up air-freight delivery service in the planning stages of development. Its goal is to offer an economical and efficient delivery service to the east coast Australian capital cities and Adelaide. The business must now analyse which capital city will be best suited as its home base.

a Set up an Excel spreadsheet to calculate the flight distance to each capital city that Donna's Deliveries will service, if the home base is based in:

i Melbourne **ii** Sydney

The following Excel image shows the table for calculating one-way distances from Melbourne to each city. Enter the distances from the map on cells C2 to C6. Work out the scale in km/mm and enter it in cells D2 to D6 (the same number will go in each of these cells). Enter a formula into cell E2 that will calculate the actual distance, based on the values in cells C2 and D2, and fill down and enter the sum formula into cell E7.

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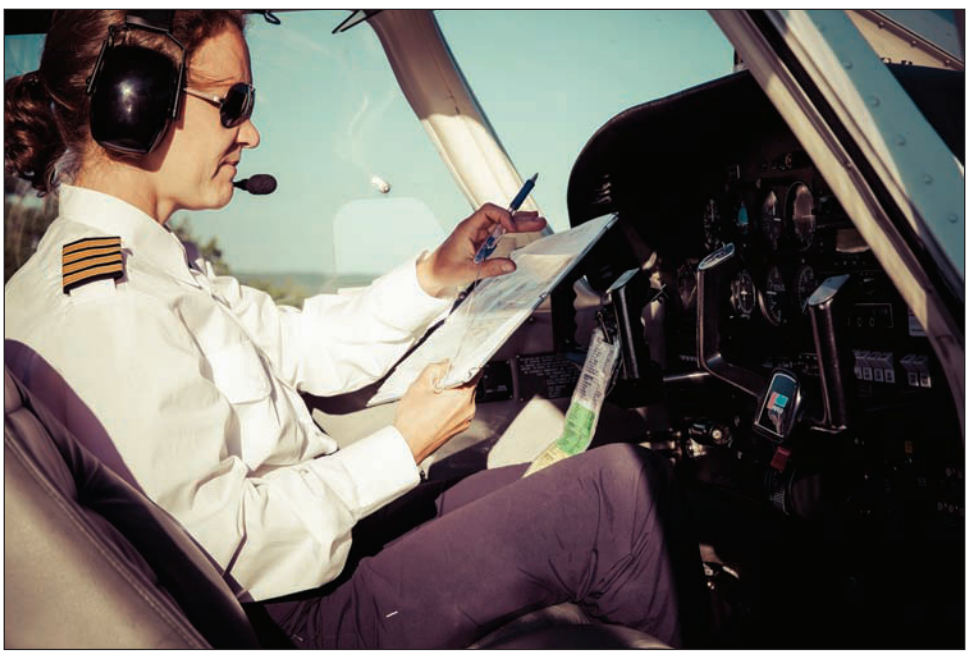
	A	B	C	D	E
1	From	To	Map direct distance in mm	Scale in km/mm	Actual one-way direct distance in km
2	Melbourne	Adelaide			
3	Melbourne	Hobart			
4	Melbourne	Sydney			
5	Melbourne	Canberra			
6	Melbourne	Brisbane			
7				Total	

b Research shows that 60% of all return flights to Sydney can be used for deliveries and 40% of all return flights to Melbourne can be used for deliveries and, hence, are profitable flight distances. A profitable flight distance means the company is making a profit by transporting goods when flying those kilometres.
Calculate the total expected profitable flight distances, to the nearest 10 km, from a home base in Sydney and from a home base in Melbourne.

c Would you advise Donna's Deliveries to set up its home base in Sydney or Melbourne? Justify your conclusion and suggest other aspects that should be considered as well as profitable flight distances.



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11C Apply direction to distances COMPLEX

LEARNING GOALS

- Identify the compass directions of:
  north, south, east and west, north-west, north-east, south-west and south-east
- Identify the compass direction and calculate the distance to define a journey between two or more places.

Who would find it essential to apply compass directions to distances?

Compass directions are essential to many occupations and those doing recreational activies, such as:

- Pilots navigating planes or helicopters such as passenger, cargo, military, crop dusting, Flying Doctor and scenic flights.
- Navigators in boats such as cruise ships, fishing boats, tourist boats, navy ships, container ships and yachts.
- Surveyors, geologists, and scientists and engineers working on the land.
- Adventurers; for example, cyclists, hikers, sea kayakers, sailors, orienteering and rogaining enthusiasts, cross-country skiers and mountaineers.

Compass directions are also helpful for:

- Travellers who need an awareness of the compass direction when using GPS to prevent major navigation errors.
- Any person in any region without internet; for example, tourists in outback Australia.

Navigation is the most important skill a mariner can learn. Traditional and electronic methods are essential knowledge for survival.

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WHAT YOU NEED TO KNOW

- The main compass directions are north (N), south (S), east (E) and west (W).
- Halfway between each pair of the main compass directions are the directions north-east (NE), south-east (SE), south-west (SW) and north-west (NW).
- The term 'due' means in the exact direction.
  - For example, due north is exactly north. A northerly direction means approximately north, not exactly north.
- Directions for people to reach their destination require both the distance and the compass direction.
- The sun rises in the east and sets in the west though not necessarily due east or west: depending on the time of year and your distance from the equator, it will, for example, rise and set more to the north or south. When a person is facing north, east is to their right and west is to their left.

A compass rose

Example 5 Identifying compass directions

Identify the compass direction between the following pairs of students standing in the grid formation shown.

Nick	Sam	Aria
Max	Kate	Ivy
Zoe	Leo	Ellie

a from Sam to Leo
b from Kate to Ivy
c from Ellie to Zoe
d from Aria to Kate
e from Zoe to Aria
f from Nick to Ellie

WORKING

a south
b east
c west
d south-west
e north-east
f south-east

THINKING

Imagine an arrow linking the centres of the two names. The first person is at the start of the arrow and the second person at the arrowhead.
The arrow's direction is the compass direction.

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Example 6 Calculate the distance and compass direction for a journey between two cities

For this map of Ireland provide directions that include the distance (to the nearest 10 km) and approximate (nearest) compass direction for travelling in a straight line:

a from Dublin to Killarney

b from Derry to Cork

WORKING

Scale calculation:

Line segment = 100 km per 14 mm

Scale = 7.1 km/mm

a From Dublin to Killarney:

Map distance = 36 mm

Actual distance = 36 mm × 7.1 km/mm

= 260 km

From Dublin, travel 260 km in an approximately south-west direction to arrive at Killarney.

b From Derry to Cork

Map distance = 51 mm

Actual distance = 51 mm × 7.1 km/m

= 360 km

From Derry, travel 360 km in a southerly direction to arrive at Cork.

THINKING

Measure the line segment scale in mm. Calculate km/mm, to one decimal place.

Measure map distance in mm. Actual km = mm × km/mm, rounding to the nearest 10 km.

Imagine the compass at Dublin, as we are finding the compass direction *from* Dublin to Killarney. Write a sentence answer indicating direction is approximate.

Measure map distance in mm. Actual km = mm × km/mm, rounding to the nearest 10 km.

Imagine the compass at Derry, as we are finding the compass direction *from* Derry to Cork. Write a sentence answer indicating direction is approximate.

A southerly direction means approximately south, not due south.

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Exercise 11C

FUNDAMENTALS

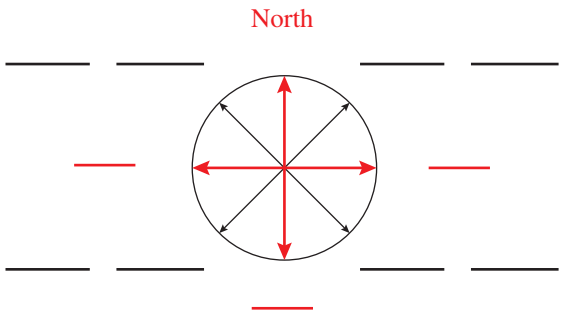
1 Demonstrate your understanding of terms by writing down the missing words.

a Directions for people to reach their destination require both the _____ and the compass _____.

b Copy this simple compass and label the directions in words.

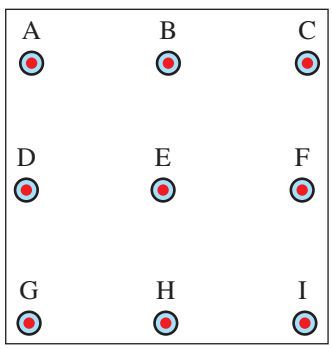
c The sun rises in the _____ and sets in the _____.

d When a person is facing north, east is to their _____ and west is to their _____.



Example 5

2 The diagram shows nine positions in a square grid. Identify the compass direction between each pair of places in the following questions.



a from G to A

b from D to F

c from E to H

d from C to B

e from F to H

f from I to A

g from G to C

h from D to H

3 Use the compass given to answer these questions.

a Who is due north of Doug?

b Who is due east of Zoe?

c Who is due west of Prisha?

d Who is due south of Lynn?

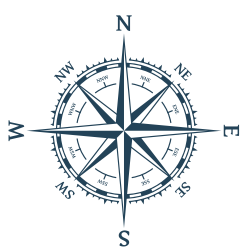
e Who is due north-east of Emma?

f Who is due south-west of Rose?

g Who is due north-west of Doug?

h Who is south-east of Zoe?

Lynn	Zoe	Ian
	Rose Emma	
Than	Doug	Prisha
	Zac Mel	



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4 Use the compass directions shown in Question **3** to find the following places on this map, given that due north vertically upwards.

a the town west of Ballina
b the nearest town south of Nambour
c the largest city east of Toowoomba
d a town north of Maroochydore
e a town north-west of Caboolture
f a town south-east of Warwick
g the towns north-east of Inglewood
h the towns south-west of Gympie

Example 6

5 Using this map of Queensland and its line segment scale, calculate the actual distance, to the nearest 10 km, and identify the compass direction when travelling in a direct line between the following pairs of towns.

a Winton and Townsville
b Charters Towers and Cairns
c Burketown and Birdsville
d Rockhampton and Cunnamulla
e Brisbane and Cloncurry
f Cairns and Karumba
g Airlie Beach and Longreach
h Bedourie and Gladstone

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APPLICATIONS

SF: –	CF: 6–8	CU: 11

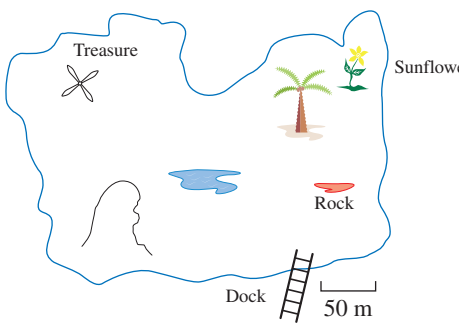
6 Olivia is a pilot for a chartered plane service. She is rostered to fly the following routes next week.

a Brisbane to Longreach
b Roma to Emerald
c Charleville to Rockhampton
d Cairns to Mt Isa
e Innisfail to Burketown

Using the Queensland map shown in Question **5**, determine the approximate direct distance and compass direction for each of Olivia's five scheduled flight routes. Create a flight plan for each trip that indicates the distance and direction.

7 Captain Jack has buried a treasure on a small island, shown on the map at right. You must make two sets of directions to find the treasure from the dock.

a The first set of directions is for Captain Jack himself to find the treasure as quickly as possible.
b The second set of directions is for his crew, which will take them to the rock, then the lagoon, then the sunflowers before finding the treasure.



8 The Royal Flying Doctor Service of Australia transports doctors and patients between isolated towns and communities and hospitals.

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a Using the map of Western Australia given, determine the distance and approximate compass direction for each section of these Flying Doctor flight routes.

i Albany to Meekatharra; Meekatharra to Warburton; Warburton to Kalgoorlie

ii Tom Price to Fitzroy Crossing; Fitzroy Crossing to Halls Creek; Halls Creek to Exmouth

b Select a current flight from the Royal Flying Doctor Service Live Flight Map, which can be found by an internet search using that name.

For your chosen flight, state the pilot's route details, including the start and end locations, the total flight distance and the compass direction of the flight.

PROBLEM-SOLVING

9 Mike flies a small plane around New Guinea, making regular deliveries of mail and medical supplies. He starts and finishes his route at Port Moresby and must land at Popondetta, Daru, Wewak, Madang, Vanimo, Lae and Mt Hagen.

Use this map of New Guinea to write a set of directions (i.e. both distances and compass directions) for the shortest route for Mike's mail and medical run. Include the distance, in km, between towns and the flight direction from one place to another. Assume all flights follow a direct route between towns.

Pilots are highly skilled in navigation.

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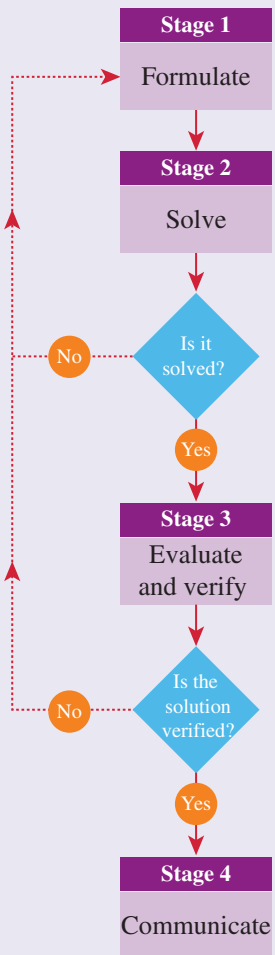
Problem-solving and modelling task

CREATING A TREASURE MAP

Background: Creating a map with a marked scale and compass directions and having other people use it to find a location is a good test of distance measuring and compass direction skills.

Task: Your task is to create a treasure map with directions that others can follow, to find where the treasure might be buried. The map must have a scale for calculating distances and a compass rose. Once you have completed the map, have two other students from the class mark on your map where they think your directions led and evaluate the accuracy of your directions to the treasure.

To complete this task, follow the problem-solving workflow diagram below and use the steps listed as a guide.



Stage 1: Formulate

1 Decide on a shape of the island and the think about the scale, the distances and directions you will use.

Stage 2: Solve

2 Create your map with a scale, compass rose, a starting point and landmark for where the treasure will be buried.
3 Mark your map with landmarks for effect.
4 Create your directions to reach the treasure.

Stage 3: Evaluate and verify

5 Ask some students to follow your directions and to mark the treasure on your map.
6 Evaluate how close they were to your treasure.
7 Determine why any differences exist between the treasure and the position they marked.

Stage 4: Communicate

8 Communicate your findings in a short report of this activity.

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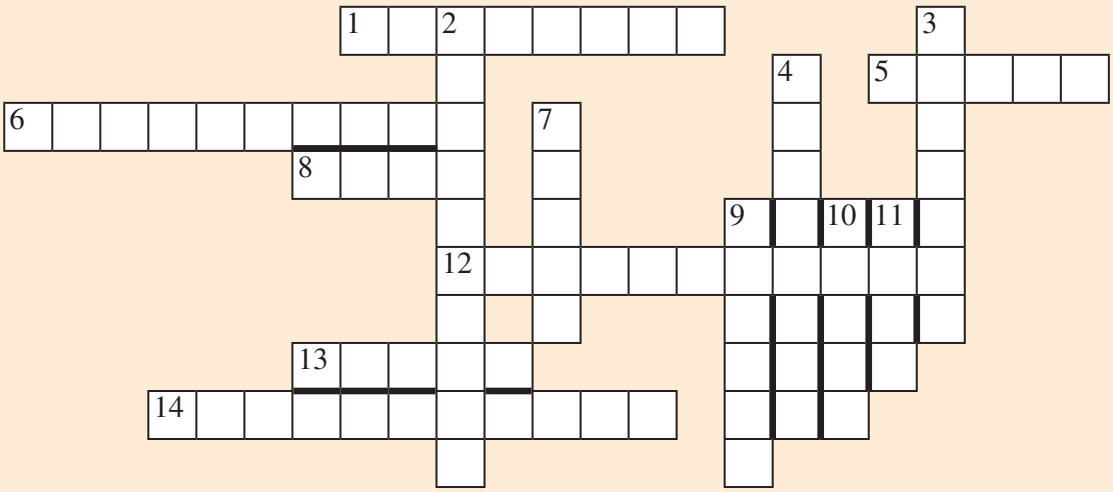
Puzzle



Across

1 A measurement of length
5 The direction to travel from Townsville to Canberra
6 The unit of measurement used when driving a car
8 The direction from which the sun rises
12 The unit of measurement most commonly used in building plans
13 The direction to travel from Alice Springs to Darwin
14 A value that is close to the answer but not exact

Down

2 Solve by using a system
3 An instrument used to find direction
4 To be a minimum or least length
7 The ratio of the drawing length to the actual length
9 The unit of measurement used when measuring house dimensions
10 To make a mistake
11 The direction the sun sets

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Chapter checklist

The questions in this checklist refer to the map of New Zealand shown.

☐ I can calculate scale distance from maps.

1 Find the actual distance, with an appropriate unit, for a measured map length of 35 mm, using a scale of 1 : 250.

2 Calculate the distance between the following towns.

a Rotorua and Gisborne

b Christchurch and Auckland

☐ I can determine the shortest route from maps.

3 Calculate the shortest path between Queenstown and Christchurch by calculating the distance when travelling via Harihari and the distance when travelling via Timaru. Determine the shortest route.

4 Kiwi Flight delivers parcels once a day from Auckland to the towns of Gisborne, Hamilton, Napier and Rotorua. Calculate the shortest path for the delivery run, using direct distances.

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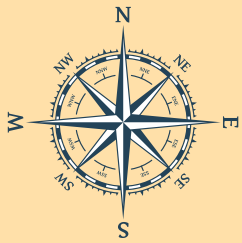
I can apply direction to distances.

5 Use the compass directions to the right and the map scale below to determine the following locations and their distances.



- **a** the town north of Otago
- **b** the town south-west of Timaru
- **c** the town west of Wellington
- **d** the towns north-east of Wellington

6 Dave is an adventurer and a long-distance hiker and is hiking from Queenstown to Nelson, visiting towns along the way. Create a plan for his journey, giving him approximate directions to walk and the distances between each town.

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Chapter review

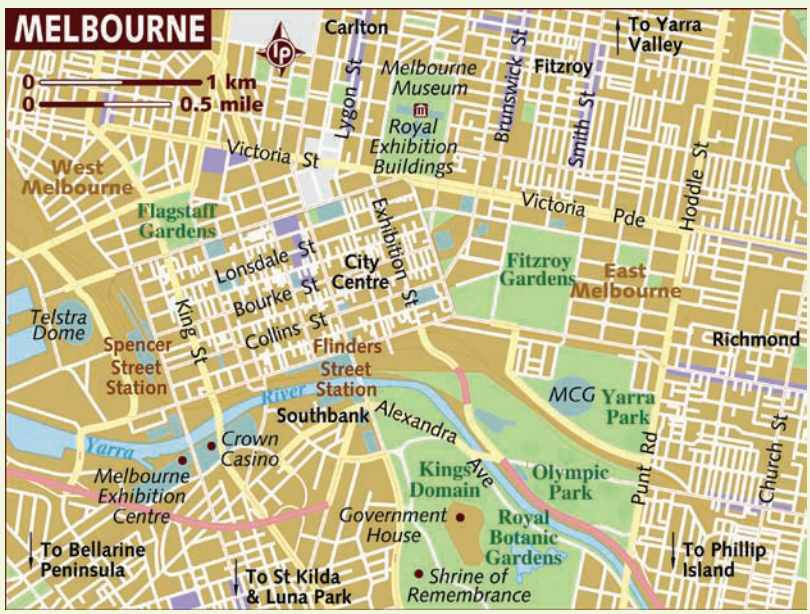
All questions in the Chapter Review are assessment-style.

Simple Familiar

Section 11A

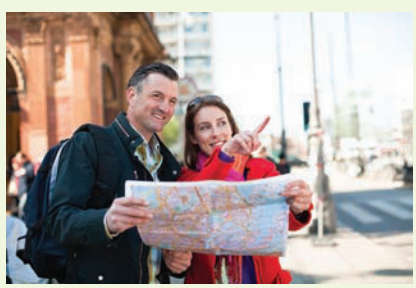
1 Using this city map of Melbourne and its scale, find the approximate direct helicopter distances between:

- **a** Melbourne Exhibition Centre and Crown Casino
- **b** Telstra Dome (the old name for Docklands Stadium) and the Shine of Remembrance
- **c** Melbourne Museum and Government House



2 Crown Casino is considering buying a gondola to give patrons from the Casino a romantic ride to the Melbourne Exhibition Centre and back, as shown in the Melbourne city map presented in Question **1**. If the Casino charges \$2 per 100 m, how much would a return gondola ride cost?

3 Val and John are visiting Melbourne from Brisbane and plan to walk directly from the Shrine of Remembrance to Government House, as shown in the Melbourne city map in Question **1**. If they take 4 minutes to walk 100 m, approximately how long will it take them?



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Complex Familiar

Section 11B

4 Use this map of NSW to answer the following questions.

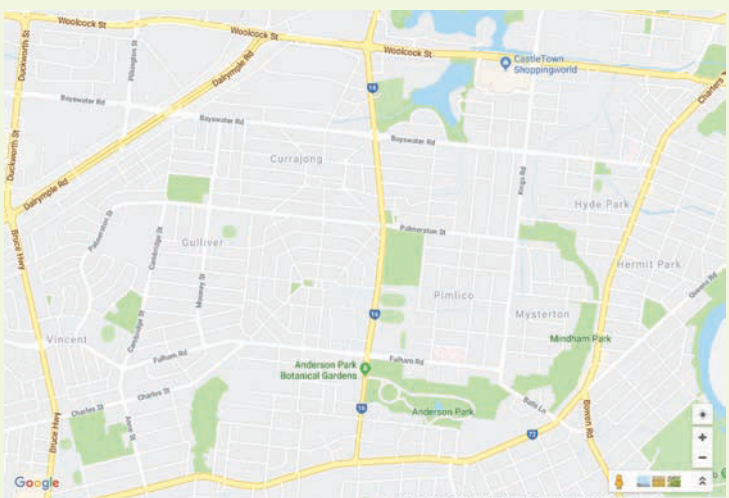
a Find the total distance to fly from Sydney to Canberra to Mildura to Broken Hill.

b Find the total distance to fly from Sydney to Orange to Bourke to Broken Hill.

c Compare the two routes and determine the shortest route.

Section 11B

5 Zara lives on the corner of Charles Street and Anne Street, as shown on this street map of Townsville. Determine the shortest route from her home to CastleTown Shoppingworld.



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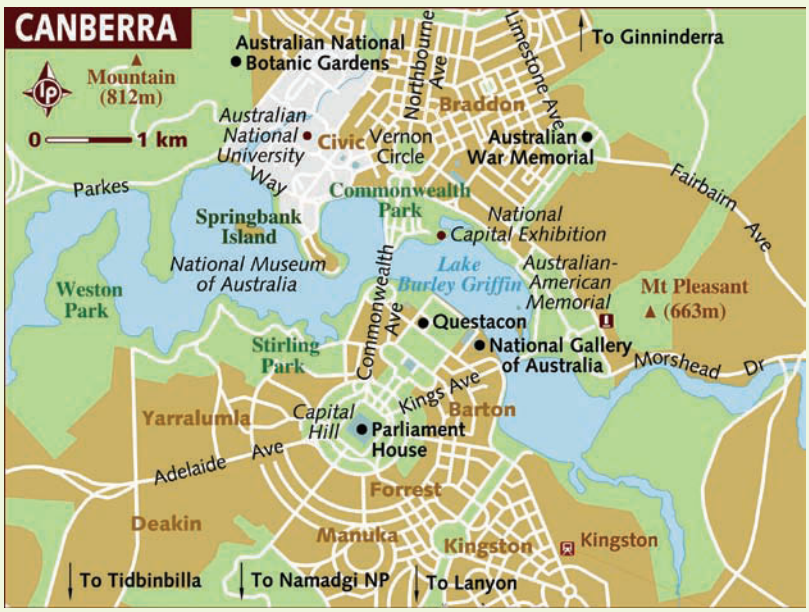
Section 11C

6 Marina is using a drone to take pictures of various landmarks in Canberra. Calculate the direct distances and approximate directions that she must fly the drone, to get between the places listed.



a from the Australian War Memorial to the Australian National University

b from the Australian War Memorial to Questacon

c from the National Gallery of Australia to Parliament House

Complex Unfamiliar

7 Bert's Biology class from the Australian National University (ANU) is going on a field excursion, walking from the ANU to the Australian National Botanical Gardens.

Bert uses a direct distance calculated from his Canberra map (shown in Question **6**) to determine the approximate distance he and the class must walk. Given that Bert's class normally walks 100 metres per minute, in what general direction should they walk and how long will it take?

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12 Speed

Maths for an avionics technician: Matthew Nicholson

After completing Year 12, Matthew travelled around the world, working at ski resorts, before settling down to a career in the Australian Army as an avionics technician. He has been in the Army for 13 years and is qualified to maintain and supervise maintenance on all helicopters and other aircraft the Australian Army operates.

Tell us a bit about your job. What does a typical day look like?

I enjoy the diversity of my job. Some days we might be preparing an aircraft for operations overseas or for hoisting operations; other days we could be troubleshooting a faulty radio system or modifying our aircraft or upgrading them.

What maths did you study at school?

During Year 12 I studied the equivalent of Maths B. It was a subject that I found challenging but thoroughly enjoyed.

How do you use maths in your job?

I use maths daily, calculating the weight of a helicopter to see how much fuel we need in order to get to our destination, as well as air temperature and weight to make sure we can take off without being over our maximum take-off weight. Once flying, we also calculate how much fuel the helicopter is burning and if we can maintain our current speed. At a maintenance level, when we modify an aircraft, we need to check that if we added or removed parts will this weight change affect the aircraft's centre of gravity and, if so, to what point? We also add corrections for magnetic variation into our aircraft GPS. If we are troubleshooting, we might need to calculate how much resistance, current or voltage is in a circuit. In our bay service department we must calculate charging times and currents for batteries. We also calibrate torque wrenches and pressure gauges, so we need to work out percentages and be able to convert between different units.

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In this chapter

12A Calculating food energy and energy used in exercise

12B Expressing speed as a rate and finding average speed

12C Using the speed formula to calculate speed, distance and time

12D Calculating journey time and costs using maps **[complex]**

12E Interpreting distance versus time graphs **[complex]**

Problem-solving and modelling task

Puzzle

Chapter Checklist

Chapter Review

Syllabus reference

Unit 2 Topic 1 Speed (8 hours)

In this subtopic, students will:

- identify the appropriate units for different activities; for example, walking, running, swimming, driving and flying
- use units of energy used for foods, including calories
- use units of energy to describe the amount of energy used by an activity, including kilojoules
- calculate speed, distance or time using the formula speed = distance/time
- calculate the time and costs for a journey, from distances estimated from maps when given a travelling speed **[complex]**
- calculate average speed
- interpret distance versus time graphs, including reference to the steepness of the slope (or average speed) **[complex]**.

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Pre-test

1 Write each of the following as simplified rates, rounding to two decimals if needed.

a $10 for 3 kg of bananas
b 452 L in 8 min
c 14 m of yarn in 4.5 h
d 867 MB in 259 s
e 100 m in 9.58 s
f 7400 km in 9.7 h

2 Find the average rate of change in the following situations, rounding to three decimal places if needed.

a Talia jogged 19 km in 2 h.
b Frederic played a total of 694 notes on the piano in 5 min.
c Marina boiled water for 3 min from 21°C to 100°C.
d The flight from Brisbane to Perth was 3624.98 km and took 5.75 h.
e The tree was 15 years old and is currently 22 m tall.
f The Earth rotates 61 times in 60.83 days.

3 Convert the following rates to the units shown in the brackets.

a $4.50/kg ($/g)
b $58 493/year ($/week)
c 8 MB/s (KB/s)
d 450 calories/kg (calories/100 g)
e 0.54 km/s (m/s)
f $3.50/ft ($/inch, where 1 ft = 12 inches)

4 Albert wants to convert the speed of a plane, 902 km/h, to m/s.

a Convert 902 km/h to m/h.
b Convert the result from part **a** to m/min.
c Convert the result from part **b** to m/s.

5 For each comparison, determine which is faster.

a 7000 km in 9.5 h or 5000 km in 7.5 h?
b 15 cm in 3 min or 90 mm in 2 min?
c 900 m in 200 min or 2.1 km in 6 h?

6 Lucas is deciding between three brands of soups: A, B and C. A can of brand A costs $2.50 for 485 mL, a can of brand B costs $4.85 for 900 mL and a can of brand C costs $3.50 for 615 mL. Which brand of soup is the best value to buy?

7 Fatima and Reiko are selling apples at a farmers' market. Buying 12 apples from Fatima costs $15, and buying eight apples from Reiko costs $9.

a Who sells apples at a cheaper rate?
b Jiyeon wishes to buy 20 apples. How much money would she save if she buys her apples from the cheaper stall rather than the more expensive stall?

A link to a HOTmaths lesson is provided in the Interactive Textbook to revise this topic.

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12A Calculating food energy and energy used in exercise

LEARNING GOALS

- Convert between the food energy units of kilojoules (kJ) and calories
- Use nutritional label data to calculate the kilojoules and calories in food products
- Calculate the energy used from exercise

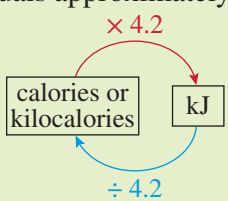
What is the essential reason for counting calories or kilojoules?

Nutrient-dense foods, such as bananas, salmon, kale, blueberries and sweet potato, offer more nutrients for fewer calories.

One of the widely accepted ways to maintain a healthy body weight uses food energy tracking or calorie counting. Our body requires a certain amount of energy every day and one way of keeping track of how much energy you feed your body is by calorie counting. There are other accepted scientific ways of weight control; for example, eating meals with increased protein and reduced carbohydrates or eating fewer calories on only two days a week, commonly called the 5:2 diet plan. Each technique reduces the body's energy intake (which is measured in calories or kilojoules) compared to the energy used by activity.

WHAT YOU NEED TO KNOW

- **Food energy** is measured in everyday units of **calories** (cal) and **scientific** (SI) units of **kilojoules** (kJ).
- For historical reasons a food energy calorie is also called a kilocalorie (kcal).
  - So 60 food calories = 60 Cal = 60 kcal
- 1 calorie or kilocalorie equals approximately 4.2 kilojoules (kJ).



  - For example: 60 calories = 60 × 4.2 kJ = 252 kJ
- Government regulation requires **nutrition information labels** on food products. This label includes energy in kilojoules (kJ) per serving and per 100 g or 100 mL.

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- Your energy requirement varies with gender, age, weight and activity level. For average-sized 17-year old students with low activity levels, the daily energy requirements are about 13,000 kJ for males and 10,500 kJ for females. These daily requirements increase for people who are more active. Go to www.eatforhealth.gov.au/node/add/calculator-energy to calculate your own energy requirements.
- Weight loss occurs when the body uses more energy than the food and drink calories consumed. One school of thought for dieting is the use of calorie counting.

Australian nutrition information labels state energy in units of kilojoules (kJ).

Example 1 Converting between kilojoules (kJ) and calories

Convert the following energy units, rounding the result to the nearest whole number.

a 1350 kilojoules (kJ) to calories **b** 620 calories to kilojoules (kJ)

WORKING	THINKING
a 1350 kJ ÷ 4.2 = 321 calories	Kilojoules (kJ) ÷ 4.2 gives calories.
b 623 calories × 4.2 = 2617 kJ	Calories × 4.2 gives kilojoules (kJ).

Example 2 Using nutritional data to calculate the kilojoules and calories in a food product

For the following packets of food, calculate the total energy in units of kilojoules (kJ) and calories. Round each answer to the nearest whole number.

a Liquorice Lollies have 2786 kJ per 100 g. Calculate the total energy in a 275 g packet.

b Frozen potato chips have 193 calories per 100 g. Calculate the total energy in a 750 g bag in kilojoules.

WORKING	THINKING
a 2786 kJ/100 g	Write the information as a rate. Divide both parts by 100 to find kJ per gram.
= 27.86 kJ/g	Keep the decimal places.
= 7662 kJ in a 275 g packet	Multiply both parts by 275 to find the kJ in a 275 g packet.
= 1824 calories in a 275 g packet	Divide kJ by 4.2 to give calories.

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b 193 cal/100 g ← Write the information as a rate. Divide both parts by 100 to find calories per grams.

= 1.93 cal/g — Keep the decimal places.

= 1448 calories in a 750 g bag — Multiply both parts by 750 to find the calories per 750 g.

= 6080 kJ in a 750 bag — Multiply calories by 4.2 to give kJ.

Example 3 Calculating the calories used by an activity

Use the table shown to calculate the calories used by the listed activities. Round each answer to the nearest whole number.

a A 72 kg person dancing for 1 h.

b A 67 kg person cycling at 15 km/h for 2.5 h.

Exercise energy chart Cal/kg of body mass per 30 min of exercise	
Activity	**Energy used (cal/kg/30 min)**
Cycling at 15 km/h	2.76
Dancing	2.20
Handball	5.07

WORKING	THINKING
a Dancing energy rate per 30 min:	
= 2.2 cal/kg	State the dancing energy rate per kg per half hour.
= 158.4 cal/72 kg person	Multiply both parts by 72 for a 72 kg person. Keep the decimal places.
Dancing energy rate per h:	There are two half hours in 1 hour.
= 317 cal/72 kg person	Multiply by 2 and round to the nearest whole number.
b Cycling energy rate per 30 min:	
= 2.76 cal/kg	State the cycling energy rate per kg per half hour.
= 184.92 cal/67 kg person	Multiply both parts by 67 for a 67 kg person. Keep the decimal places.
Cycling energy used in 2.5 h:	There are five half hours in 2.5 hours.
= 925 cal/67 kg person	Multiply by 5 and round to the nearest whole number.

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Example 4 Solving an energy problem in a real-world context

Andy drinks a 350 mL chocolate milk, which has 185 calories per 100 mL. If Andy weighs 92 kg and wishes to burn off the milk's energy by cycling, determine approximately how long will she need to ride.

WORKING	THINKING
185 cal/100 mL	First, write the information as a rate.
= 1.85 cal/mL	Now divide by 100 to find cal per mL.
350 mL × 1.85 = 647.5 calories	Multiply by 350 mL to find the calories in the milk drink.
Andy burns 2.76 × 92 cal in 30 min	Use the table to identify the calories used per 30 min.
= 253.92 cal/30 min	Divide the number by 30 to calculate the calories burned per minute.
≈ 8.5 cal/min	
∴ 647.5 ÷ 8.5 = 76 min	Divide the total calories by the calories used per minute to determine the number of minutes needed to exercise.
Andy would need to cycle for approximately 76 min.	Write your answer as a sentence.

Exercise 12A

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words and units in the following statements.

- **a** Food energy is measured in everyday units of _____ and scientific units of _____ (__).
- **b** Calories also can be referred to as _____ (___).
- **c** Kilojoules Conversions: Kilojoules _ __ = calories and calories __ ____ = kilojoules.
- **d** Food nutrition information labels state energy in units of _____ per serving and per _____ or _____.
- **e** Weight loss occurs when the body uses _____ energy than it _____.

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Example 1

2 **a** Convert the following kilojoules to calories rounding to the nearest whole number.
i 1200 kJ **ii** 455 kJ **iii** 75 kJ **iv** 986 kJ
b Convert the following calories to kilojoules rounding to the nearest whole number.
i 546 calories **ii** 58 calories **iii** 314 calories **iv** 182 calories

Example 2

3 For the following foods, calculate the total energy in units of kilojoules (kJ) and calories. Round each answer to the nearest whole number.
a Flakies cereal has 1590 kJ per 100 g. Calculate the total energy in a 400 g carton.
b Cool Bubbly has 319 kJ per 100 mL. Calculate the total energy in a 600 mL bottle.
c Ozzie Pies have 445 kJ per 100 g. Calculate the total energy in a 600 g packet.
d Ozzie Sausage Rolls have 1220 kJ per 100 g. Calculate the total energy in a 250 g box.
e Popcorn has 451 cal per 100 g. Calculate the total energy in a 250 g bucket.
f Potato crisps have 522 cal per 100 g. Calculate the total energy in a 350 g packet.
g Blueberries have 56 cal per 100 g. Calculate the total energy in a 125 g punnet.
h Almonds have 580 cal per 100 g. Calculate the total energy in a 750 g packet.

Example 3

4 Use the table shown to calculate the calories used in the listed activities. Round each answer to the nearest whole number.
a A 50 kg boy running for half an hour.
b A 75 kg woman walking at 5 km/h for 30 min.
c An 80 kg man jogging for 45 min.
d A 64 kg boy hiking with a 15 kg load for 2.5 h.
e An 88 kg woman swimming at 25 m/min for 20 min.
f A 64 kg girl using a rowing machine for 15 min.
g A 62 kg teenager stair climbing for 10 min.
h A 70 kg boy playing soccer for 1.5 h.
i A 56 kg girl skipping for 18 min.
j A 95 kg man hiking with no load for 4 h and 12 min.

Exercise energy chart
Cal/kg of body mass per 30 min of exercise

Activity	Energy used (cal/kg/30 min)
Cycling at 15 km/h average	2.76
Hiking with 15 kg load	5.18
Hiking, no load	3.42
Jogging at 8 km/h average	4.08
Rowing machine	3.97
Running at 13 km/h average	6.72
Skipping rope	6.28
Soccer	4.30
Stair climbing	3.09
Swimming at 25 m/min	2.65
Walking at 5 km/h average	1.76

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APPLICATIONS

SF: 5–10	CF: –	CU: –

5 For lunch, Hudson ate four slices of a Hawaiian cheesy pizza, which has 190 calories per slice; two chocolate chip cookies, each having 214 calories; and drank a 750 mL chocolate milk, which states 88 calories per 100 mL on its nutritional label. Hudson weighs 78 kg and wishes to burn off his lunch calories by stair climbing, in training for the Gabba Stadium Stair Stomp. Complete the following, rounding each answer to the nearest whole number.

a How many calories are in Hudson's lunch?

b What percentage is Hudson's lunch of his daily allowance of 2500 calories?

c Refer to the exercise energy chart in Question **4** to calculate the number of calories that Hudson's body would burn per minute of stair climbing.

d For approximately how many minutes will Hudson need to climb stairs to burn off these calories?

6 Eva joined her friends at an outdoor café for brunch. She ate a feta and spinach omelette with smoked salmon (2764 kJ), one-third of a bowl of potato wedges (3639 kJ per bowl) and a small banana smoothie (1047 kJ). Eva weighs 65 kg and would like to burn off her breakfast energy by jogging around the local park. Complete the following, rounding each answer to the nearest whole number.

a How many calories are in Eva's brunch?

b What percentage is this breakfast of Eva's daily allowance of 2000 calories?

c Refer to the exercise energy chart in Question **4** to calculate the number of calories that Eva's body would use per minute of jogging.

d For approximately how many minutes will Eva need to jog to burn off this food energy?

Example 4 ★**7** For breakfast, Zane ate 1 cup of Loops cereal, 1 cup (250 mL) of full-cream milk, 1 cup of scrambled eggs and two slices of toast. Use the nutritional information in the table to determine the number of calories that remain out of his daily allowance of 2500 calories.

	Serving size	Energy/serving
Loops cereal	½ cup	490 kJ
full-cream milk	125 mL	370 kJ
scrambled eggs	½ cup	791 kJ
toast	1 slice	386 kJ

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★8 Beatrice makes up a stir fry dinner that has approximately 1640 kJ in total for the four serves in the entire meal. She then adds four servings of sauce, which has the nutritional label shown. If Beatrice's husband eats two whole serves of the meal, how many calories did he consume?

Nutritional information for sauce Servings per package: 4 Serving size: 10 g		
Average quantity	per serving	per 100 g
Energy	110 kJ	1100 kJ

★9 Larna eats a 50 g chocolate bar which, according to its nutritional label, has 420 calories per 100 g. Larna is 65 kg and wishes to exercise for no more than 30 min to burn off the energy gained from the chocolate bar. Referring to the exercise energy chart in Question **4**, which activity, out of cycling and hiking, would you recommend to Larna?

★10 Haku is a sumo wrestler and weighs 150 kg. The doctor has advised Haku that he needs to lose weight to lower his blood pressure and reduce the risk of dying from a heart attack. Haku decides to exercise daily at the gym by cycling for 30 min on the stationary bike, stair climbing for 30 min and jogging on the treadmill.

Referring to the exercise energy chart in Question **4**, calculate how many minutes per day Haku will need to jog so his body burns 2000 cal/day from all his exercise in the gym.

PROBLEM-SOLVING

★11 Joe is a man who loves to exercise and loves to eat. Even though the recommended intake for men is 2500 calories, Joe prefers to eat 4200 calories and burn the extra calories through exercise. His weight is 79 kg. Referring to the exercise energy chart in Question **4**, create a daily exercise program for Joe that includes at least three different exercises to be completed in less than 3 hours.

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12B Expressing speed as a rate and finding average speed

LEARNING GOALS

- Write speed as a rate and simplify to suitable units
- Calculate average speed from the distance travelled in a given time

Where is an average speed calculation essential?

To catch speeding drivers, each vehicle's average speed between two speed cameras is calculated.

To reduce the trauma and cost of road accident deaths and injuries, governments are installing more point-to-point speed cameras, which can monitor every vehicle's average speed over long distances. A surveyor uses maps to determine the shortest distance between the two cameras, so speeds are not overestimated. The average speed cameras use automatic number plate recognition technology and record the exact time each number plate is identified. The known distance between two cameras is divided by the travel time to give each car's average speed. If the average speed is above the speed limit, then a fine is automatically issued.

WHAT YOU NEED TO KNOW

- Speed is an example of a **rate** in units of distance/time. To express speed in the simplest way, we find the distance travelled per 1 unit of time. This is done by dividing both parts of the rate by the time taken.
  - For example:

$$\div 5 \left(\begin{array}{l} 400 \text{ km/5 h} \\ = 80 \text{ km/h} \end{array} \right) \div 5 \qquad \div 40 \left(\begin{array}{l} 100 \text{ m/40 s} \\ = 2.5 \text{ m/s} \end{array} \right) \div 40$$

- The most common units of speed are **metres per second** (m/s) and **kilometres per hour** (km/h).
- When travel is between two known locations, we can determine the distance covered. One way that locations can be identified is by their distance from a nearby town.
  - For example, for travel from 50 km south of Ayr to 400 km south of Ayr. The distance travelled $= 400 - 50 = 350$ km

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- In speed calculations, time taken has to be in one time unit, we cannot use, for example, 12:31 or 3 h 5 min.
- During a journey speed varies, even for a vehicle with cruise control. The **average speed** is a measure overall speed, expressed as the distance travelled per 1 unit of the time taken.
- To calculate a journey's **average speed**, determine the total distance travelled and the total time taken for the whole journey. Then use the same method for calculating speed given at the top of this box. (The speeds given there are actually average speeds). Note that you cannot calculate average speed by adding speeds at certain times and calculating their average.
- To calculate speed in km/h when the time is not a whole number of hours, write the time in hours as a decimal number: First convert seconds to minutes, then convert the total minutes to hours.
  - For example: 2:23:10.5 = 2 h 23 min 10.5 s

$= 2\text{h} + \left(23 + \frac{10.5}{60}\right)$ min

$= 2\text{h} + 23.175$ min

$= 2\text{h} + \frac{23.175}{60}$ h

$= 2.38625$ h

$= 2.39$ h

seconds ÷ 60 → minutes

minutes ÷ 60 → hours

- Converting between speed units: m/s × 3.6 = km/h, and km/h ÷ 3.6 = m/s.

Example 5 Writing average speed as a rate in suitable units

For these events, write the average speed as a rate of distance/time and simplify.

a Tara's best time for running 200 m is 40 s. Calculate her average speed, in m/s.

b Peter takes 8 h and 24 min to drive 588 km in a car rally on gravel roads through hilly country. Calculate his average speed, in km/h.

WORKING	THINKING
a Average speed = 200 m/40 s = 5 m/s	Write the average speed as a rate of distance/time. Divide both parts by 40 to find the distance per 1 s. Write the average speed in units of m/s.

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WORKING	THINKING
b Time $= 8 + \frac{24}{60} = 8.4$ h	First find the time in hours, then work out 24 min as a decimal; that is, $24 \div 60 = 0.4$ h.
Average speed $= 588$ km/8.4 h $= 70$ km/h	Write the average speed as a rate of distance/time. Divide both parts by 8.4 to find the distance per 1 h. Write the average speed in units of km/h.

Example 6 Calculating average speed from distance travelled in a given time

For the following journeys, determine the distance travelled and the average speed.

a Tao takes 3 h to drive from 50 km south of Townsville to 320 km south of Townsville.

b Hannah takes 2 h and 24 min to fly from 100 km west of Longreach to 350 km east of Longreach.

WORKING	THINKING
a Distance $= 320$ km $- 50$ km $= 270$ km	Both locations are south of Townsville, so subtract to find the distance travelled.
Average speed $= 270$ km/3 h $= 90$ km/h	Write the average speed as distance/time. Find the distance per 1 h by dividing both parts by 3. Write the answer with the units km/h.
b Distance $= 100$ km $+ 350$ km $= 450$ km	Add the distances, as the locations are west and east of Longreach.
Average speed $= 450$ km/2.4 h $= 187.5$ km/h	Convert hours and minutes to decimal: 2 h 24 min $= 2 + 24/60$ h $= 2.4$ h Divide both parts of the distance/time rate by 2.4 to give km/h.

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Example 7 Calculating average speed in a real-world context

At the 2011 Cycling Australia Track National Championships, Jack Bobridge set a world record for the 4000 m individual pursuit in a time of 4 min 10.534 s. Calculate Jack's average speed, in m/s and km/h. Round km/h to one decimal place.

WORKING	THINKING
Time $= 4 \times 60 + 10.534$	Find the time in seconds when calculating speed in units of m/s.
$= 250.53$ s	Keep two decimal places.
Average speed $= 4000$ m/250.53 s	Write the average speed as a rate of distance/time.
$= 15.97$ m/s	Divide both parts by 250.534 to give units of m/s.
$= 15.97 \times 3.6$ km/h	Multiply by 3.6 to convert from m/s to km/h.
$= 57.5$ km/h	Round the answer to one decimal place.

Exercise 12B

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words, values and units in the following statements.

- **a** Units of speed are metres per second (_/_) and kilometres per hour (__/_).
- **b** Speed is an example of a _____ in units of distance/_____.
- **c** When simplifying a speed rate, we find the distance moved per _____ of the time taken.
- **d** To calculate a journey's average speed:
  - **1** Determine the _____ travelled.
  - **2** Write the _____/____ rate and divide both parts of the rate by the _____ taken.

2 For the following movements, select the most suitable units of speed from:

m/year km/h m/s m/min m/h

- **a** walking down the street
- **b** driving a racing car
- **c** running in a 200 m race
- **d** a turtle walking
- **e** a moving glacier
- **f** flying between capital cities

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Example 5

3 Calculate the average speed for each of the following, displaying the appropriate units to one decimal point.

a The world record for the 100 m sprint is 9.58 s, held by Usain Bolt in 2009.

b The non-stop flight is from Auckland, New Zealand to Doha, Qatar at 14 534 km in 17 h.

c The starfish is one of the world's slowest creatures, travelling at 32 m in an hour.

d Paula Radcliffe (Great Britain) ran the 42 km London Marathon in just over 2 h and 15 min.

e Eamon Sullivan (Australia) achieved a world record for completing the 100 m freestyle in 47 s.

f Jack Bobridge (Australia) completed the 4000 m cycling individual pursuit in 4.17 min.

Hint: seconds ÷ 60 → minutes
minutes ÷ 60 → hours

Example 6

4 Calculate the average speed, in km/h, for the following journeys. Round each answer to one decimal place.

a A car starts at a location 100 km north of Blackall and drives to a location 340 km north of Blackall in 2.5 h.

b A cyclist rides from 50 km west of Gympie to 178 km west of Gympie in 4 h.

c A plane takes off 150 km west of Mt Isa and flies to a location 325 km east of Mt Isa in 2.5 h.

d A group of backpackers on Fraser Island drive from the Lake Wabby car park, which is 6 km north of Eurong, to Hook Point, which is 32 km south of Eurong, taking 54 min.

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APPLICATIONS

SF: 5–12	CF: –	CU: –

★**5** Calculate the average speed, in km/h, for these journeys. Round each answer to one decimal place where needed.

a One of the longest non-stop passenger flights in the world is from Singapore to New York, USA. It is 15 322 km and the flight time is approximately 19 h.

b The Tilt Train leaves Rockhampton at 7:10 a.m. daily and arrives at Roma Street Station, Brisbane, at 2:50 p.m. The distance travelled is 639 km.

c In the 2003 London Marathon, Paula Radcliffe (of Great Britain) set the world record for the fastest woman by running the 42.195 km in 2 h 15 min 25 s.

d In 2018, Will Power, from Toowoomba, became the first Australian to win the Indianapolis 500. His time was 2 h 59 min 42.6365 s for the 500 mile race.

e A Ford Falcon drove the 67 laps (each lap is 2.423 km) of the Winton Super Sprint in a total time of 1 h 36 min 36 s.

Will Power's car, 2015 Indianapolis 500.

6 Queenslander Anna Beck won the elite women's section of the 2018 'Easter in the Alice' mountain bike competition. The race takes place in the rocky landscape of West MacDonnell Ranges, Central Australia, Northern Territory. Anna's stage distances and times were:

Stage	Distance (km)	Time (h : min : s)
1	83	04:07:34
2	24	01:28:16
3	34	01:44:14

West MacDonnell Ranges, NT

a Calculate Anna's average speed for stage 1, in km/h.

b Calculate the total distance for the race; that is, stages 1, 2 and 3.

c Calculate the total time that Anna took to complete the three race stages.

d Calculate Anna's average speed over the three stages, in km/h.

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Example 7 ★7 Hamish has purchased a pet hermit crab and notices that it moved 20 cm in 1 h. Determine the units of speed Hamish could use to describe the speed of his hermit crab to his friends.

★8 Grace is staying in Gatton, which is 90 km west of Brisbane, and must drive to Toowoomba, which is 128 km west of Brisbane, in only 40 min. Calculate the average speed she must drive her car.

★9 Kayliegh needs to travel 360 km from Hervey Bay to the Gold Coast Airport in 4 h. Calculate the average speed that she will need to travel to arrive on time.

★10 Bruce is 900 m from the bus stop and has only 5 min until the bus leaves. Calculate the speed, in m/s, he must run to catch the bus.

★11 Brisbane trains travel 13 km from Central Station to Northgate Station, and 27 km from Central Station to Strathpine Station. If the train trip from Northgate Station to Strathpine Station takes a quarter of an hour, calculate the train's average speed, in km/h, for this section.

★12 Angus lives 90 km east of Hughenden, in outback Queensland. He has an 11:30 a.m. specialist appointment in Charters Towers, which is 248 km east of Hughenden. If Angus starts his journey at 10:06 a.m., does he risk a speeding fine if he drives fast enough to arrive at his appointment on time?

PROBLEM-SOLVING

★13 Ruby and Jade are both in a 400 m race. However, Ruby starts 80 m ahead of the start line because she is younger. Both girls finish together after exactly 60 s. How much faster did Jade run than Ruby, in m/s? Give your answer to one decimal place.

★14 If Anton drives at 100 km/h for 2 h and at 80 km/h for half an hour, calculate his average speed, to one decimal place.

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12C Using the speed formula to calculate speed, distance and time

LEARNING GOALS

- Know the 'speed triangle' and use it to write the formulas for speed, distance and time
- Calculate speed, distance and time by substitution into the relevant formulas
- Apply the speed, distance and time formulas to solve real-life situations

When are calculations using speed, distance and time essential?

The average speed (85 km/h) of a road train and its capacity (120 tonnes) is used to schedule the delivery of mined ore to each ship when in port.

All journey scheduling is based on calculations using speed, distance and time. Public transport schedules are the basis for digital journey planners. Google Maps calculates route times using distance and the speed of driving or cycling or walking.

Airline companies use average speed and distance to calculate flight times. Arrival and departure schedules are essential knowledge for travellers to plan a journey with sufficient time between interconnecting flights, trains and buses.

Engineers schedule the transport of millions of tonnes of Australian coal and metal ores across vast distances from the mine to ships. Supply schedules are precisely determined with maths programming, using many variables, including speed, distance and time.

WHAT YOU NEED TO KNOW

- The speed formula:

$$\text{Speed} = \frac{\text{distance}}{\text{time}} \qquad s = \frac{d}{t}$$

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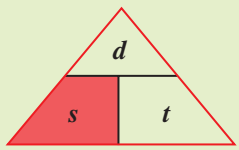
- For example:

$s = \frac{d}{t}$
$s = \frac{300 \text{ km}}{3 \text{ h}}$
$s = 100 \text{ km/h}$

Speed = distance/time
= 300 km/3 h
= 100 km/h

The speed formula can be rearranged to calculate times and distances using speeds.

- The speed triangle can be used to help remember the speed formula and its rearrangements that make distance or time the subject.

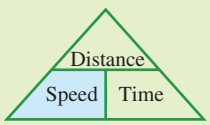


- The three formulas for speed, distance and time are:

$\text{Speed} = \frac{\text{distance}}{\text{time}}$
$s = \frac{d}{t}$

$\text{Distance} = \text{speed} \times \text{time}$
$d = s \times t$

$\text{Time} = \frac{\text{distance}}{\text{speed}}$
$t = \frac{d}{s}$



Example 8 Calculating speed, distance and time by substituting into the relevant formulas

For the following journeys, first write the appropriate formula and then substitute the given values to calculate the unknown value. Round each answer to one decimal place and include appropriate units.

a Calculate the average speed when distance = 270 km and time = 3.75 h.
b Calculate the time taken when the average speed is 5.2 m/s and distance is 200 m.
c Calculate the distance travelled if average speed = 77 km/h and time = 2.5 h.

WORKING	THINKING
a $s = \frac{d}{t}$	Write the speed formula: $s = \frac{d}{t}$.
$s = \frac{270 \text{ km}}{3.75 \text{ h}}$	Substitute the given values with their units.
$s = 72 \text{ km/h}$	Calculate the result and round the answer to one decimal place. Include the units in km/h.

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WORKING	THINKING
b $t = \frac{d}{s}$	Write the formula for time: $t = \frac{d}{s}$.
$t = \frac{200 \text{ m}}{5.2 \text{ m/s}}$	Substitute the given values with their units.
$t = 38.5 \text{ s}$	Calculate the result and round the answer to one decimal place. Include the units of seconds.
c $d = s \times t$	Write the formula for distance: $d = s \times t$.
$d = 77 \text{ km/h} \times 2.5 \text{ h}$	Substitute the given values with their units.
$d = 192.5 \text{ km}$	Calculate the result and round the answer to one decimal place. Include the units of km.

Example 9 Applying the distance formula to solve a real-life situation

Lee used cruise control and travelled at a constant speed of 110 km/h along a highway. If he started at 1:10 p.m., how far had he travelled by 1:55 p.m.?

WORKING	THINKING
Speed = 110 km/h	Identify and write down the values given in the question.
Time = 0.75 h	1:55 p.m. − 1:10 p.m. = 45 min, which is 45 ÷ 60 = 0.75 h when converted to a decimal time.
Distance = speed × time	Identify what it is you must find and write the required formula.
= 110 km/h × 0.75 h	Substitute the given values and calculate the result.
= 82.5 km	
Lee travelled 82.5 km.	Write your answer in words

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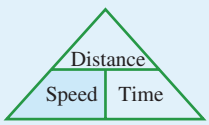
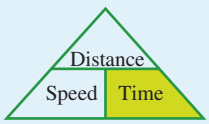
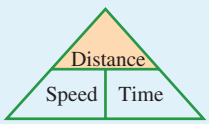
Exercise 12C

FUNDAMENTALS

1 Demonstrate your understanding of terms by filling in the missing words and letters in the following formulas.

Speed triangles	Formulas using words	Formulas using pronumerals
	Speed $=$ $\frac{\square}{\square}$	$s = \frac{\square}{\square}$
	Time $=$ $\frac{\square}{\square}$	$t = \frac{\square}{\square}$
	Distance $=$ $\frac{\square}{\square}$	$d = \_ \times \_$

Example 8

2 For each of the following journeys, first write the appropriate formula and then substitute the given values to calculate the unknown value. Round each answer to one decimal place and include appropriate units.

a Find the average speed when:
- **i** distance = 20 m, time = 5 s
- **ii** distance = 320 km, time = 4 h
- **iii** distance = 400 m, time = 55 s
- **iv** distance = 840 km, time = 9.5 h

b Find the time when:
- **i** speed = 28 m/s, distance = 1500 m
- **ii** speed = 100 km/h, distance = 1250 km
- **iii** speed = 88 km/h, distance = 620 km
- **iv** speed = 42 m/s, distance = 1240 m

c Find the distance when:
- **i** speed = 18 m/s, time = 4 s
- **ii** speed = 60 km/h, time = 3 h
- **iii** speed = 80 km/h, time = 6.5 h
- **iv** speed = 14 m/s, time = 12.5 s

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3 Eva cycles at an average speed of 12 km/h and plans to ride along a 20 km mountain bike trail in Townsville. Use the time formula to find the time, in hours and minutes, that Eva's cycle trip is expected to take.

4 Henry delivers parcels and has calculated that his average speed is 55 km/h when driving around the suburbs. Use the distance formula to calculate how far Henry has driven after 4.25 h of parcel deliveries.

APPLICATIONS

SF: 5–17 | CF: – | CU: –

Example 9 **★5** Tom Speeder drove the 1000 km Bathurst race in 12 h. Calculate his overall race speed.

★6 The World Record for the 4000 m individual pursuit is 250 s. Calculate the overall race speed.

★7 The school record for the 800 m race is 4 min and 20 s. If Terry runs the race with a speed of 3.2 m/s, determine if he will break the record and calculate by how much.

★8 Jasmine notices a snail in her front yard one morning. If the snail moves at 47 m/h, calculate how long it will take for the snail to reach Jasmine's vegetable garden, which is 30 m away.

★9 Nick went for a drive around the city at a speed of 60 km/h. If he left home at 2 p.m., calculate how far he had travelled by 4:30 p.m.

★10 Alana is driving from Emerald, Queensland to Brisbane, and according to her internet search it is 872.2 km and will take 9.62 h. Calculate the speed of the trip.

★11 Craig flew 1020 km from the Gold Coast to Mackay at a speed of 340 km/h. If he left at 2:30 p.m., at what time did he arrive at Mackay?

★12 Jack flew from the Wellcamp Airport (Toowoomba) to Mt Isa at an average speed of 586 km/h. His plane left Wellcamp Airport at 2:45 p.m. and landed at 5:15 p.m. at Mt Isa Airport. Use the distance formula to calculate the length of this flight.

Hint Start each question by drawing the speed triangle.

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★13 Leigh drove 623 km from Rockhampton to Brisbane, averaging a speed of 89 km/h. If she left at 6 a.m., use the time formula to help calculate the time Leigh arrived in Brisbane.

Hint Write the relevant formula as the first line of each solution.

★14 Boyce ran the 200 m race in 28 s, and he ran the 800 m race in 118 s. Use the speed formula to determine in which race Boyce ran fastest, and by how much. Give your answer to one decimal place.

★15 Melody went for a run at an average speed of 12 km/h for 45 min due west of her house. Use the distance formula to calculate how far Melody has run from her home.

★16 A small plane departs from Quilpie Airport at 3:10 p.m. and arrives at Winton Airport at 4:25 p.m. If the plane flies at an average speed of 388 km/h, determine the flight distance for this plane's journey.

★17 In a handicap race in which Jacinta is given a 'head start', Jacinta and Wanita start at the same time. Jacinta runs at 8 m/s and Wanita runs at 10 m/s. If they finish exactly together after 20 s, calculate the length of Jacinta's 'head start'.

Hint A 'head start' is starting at a distance ahead of the start line.

PROBLEM-SOLVING

★18 Gillian jumps from a plane at 6000 m altitude and freefalls at an average speed of 190 km/h until she opens her parachute at 1000 m above ground. If Gillian falls at an average speed of 28 km/h with her parachute open, calculate the total time of her descent, in minutes, to one decimal place.

★19 The highway between Maroochydore and Brisbane has a 60 km section with a 110 km/h speed limit and a 45 km section with a 100 km/h speed limit.

a If a car is driven exactly at the speed limit for each relevant distance, calculate its average speed for the trip from Maroochydore to Brisbane.

b Calculate how much longer the trip will take if night roadworks require a speed limit of 40 km/h on 12 km of the 110 km/h section and a speed limit of 60 km/h on 18 km of the 100 km/h section.

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12D Calculating journey time and costs using maps COMPLEX

LEARNING GOALS

- Calculate the time for a journey, using map distances and a given speed
- Calculate the cost for a journey, using map distances and a given speed
- Calculate journey time and costs, using map distances in a real-world situation

Who would find it essential to use a map for estimating the time and cost?

Civil engineers and surveyors use detailed maps for accurate distance calculations when estimating construction times and costs for new routes, such as new railway lines, roads, power lines, water, oil and gas pipelines. Such infrastructure development is essential for Australia's economy.

These small planes are at Birdsville for the annual horse races. Flight costs are calculated using distance, speed and the operating cost per hour.

Both commercial and private plane operators, such as passenger and freight services, farmers, flying doctors and miners, all calculate flight distances, times and costs to ensure that their business stays profitable.

Furniture removal companies also make distance, time and cost estimations to ensure the prices charged cover their operating costs.

WHAT YOU NEED TO KNOW

- To calculate **actual distances** using a map's line segment scale:
  1. Measure the **line segment scale**, in mm.
  2. Calculate the **scale ratio** in km/mm (to one decimal place) from the line segment scale given.
  3. Measure the **map distance**, in mm, and convert this map distance to the actual distance by:

$$\text{Actual distance in km} = \text{map distance in mm} \times \text{scale in km/mm}$$

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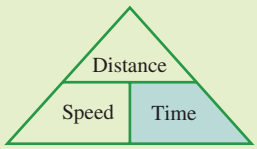
- Calculate time by dividing the distance by the speed. The distance units must be the same.
  - For example: When $d = 240$ km and $s = 60$ km/h, then $t = 240 \div 60 = 4$ h.

$$\text{Time} = \frac{\text{distance}}{\text{speed}}$$
$$t = \frac{d}{s}$$



- The cost of a journey is the cost per hour × the number of hours.
  - For example: A plane's operating cost is \$450/h and a flight takes 2.4 h. Cost of the flight = \$450 × 2.4 = \$1080
- A complex problem is a series of simple problems.

Refer to this map of Queensland for **Examples 10**, **11** and **12** and Question **2**.

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Example 10 Calculating the time for a journey, using map distances and a given speed

A small passenger plane flies at 320 km/h directly from Charleville to Townsville. Use the Queensland map given to complete the following.

a Measure the 200 km line segment scale in mm and calculate the scale in km/mm, to one decimal place.

b Measure the map direct distance, in mm, from Charleville to Townsville and then convert this map distance to the actual distance.

c Estimate the time that a small plane will take to fly from Charleville to Townsville.

WORKING	THINKING
a Line segment = 200 km per 13 mm Scale = 15.4 km/mm	Measure the line segment, in mm. Calculate the scale in km/mm, rounding the answer to one decimal place.
b Map distance = 50 mm	Measure the direct map distance between the two towns, in mm.
Actual distance = 50 mm × 15.4 km/mm = 770 km	Actual distance = map distance in mm × scale in km/mm
c $t = \frac{d}{s}$ $= \frac{770 \text{ km}}{320 \text{ km/h}}$ $= 2.4$ h	Time = $\frac{\text{distance}}{\text{speed}}$ Write the formula for time and substitute the known values. Write the time estimated in hours.

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Example 11 Calculating the cost of a journey, using map distances and a given speed

A chartered plane costs approximately $2500 per hour of flight time to cover its operating costs. For a plane that flies at 375 km/h, use the Queensland map given previously to estimate the cost for a chartered flight between Toowoomba and Mt Isa.

WORKING	THINKING
Scale = 20 km/mm	Write the scale, which we already calculated in **Example 10**.
Map distance = 95 mm	Measure the direct map distance between the two towns.
Actual distance = 95 mm × 15.4 km/mm = 1460 km	Actual distance = map distance in mm × scale in km/mm
$t = \frac{d}{s}$ $= \frac{1460 \text{ km}}{375 \text{ km/h}}$ $= 3.9$ h	Time = $\frac{\text{distance}}{\text{speed}}$ Write the formula for time and substitute the known values to solve.
Cost = 4 × $2500 = $9750	Cost = time × cost per hour

Example 12 Calculating journey time and costs, using map distances in a real-world context

Dell owns a private plane in Cairns and plans to fly to Mackay for a family wedding that starts at 4 p.m. The plane costs $280/h to fly and has a speed of 300 km/h. Determine at what time should Dell take off from Cairns to arrive in Mackay with an hour to spare before the wedding starts. Estimate the cost of the return trip.

WORKING	THINKING
Scale = 15.4 km/mm	Write the scale, which we already calculated in **Example 10**.
Map distance = 37 mm	Measure the direct map distance between the two places.
Actual distance = 37 mm × 15.4 km/mm = 570 km	Actual distance = map distance in mm × scale in km/mm

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WORKING	THINKING
$t = \frac{d}{s}$ $= \frac{600 \text{ km}}{300 \text{ km/h}}$ $= 2 \text{ h}$	Time $= \frac{\text{distance}}{\text{speed}}$ Write the formula for time and substitute the known values to solve.
Dell must leave by 1 p.m.	3 p.m. is an hour earlier than the wedding start time of 4 p.m. So Dell must take off 2 h before 3 p.m.
Cost $= \$280 \times 4 \text{ h}$ $= \$1120$	The return trip will take 4 h of flying time. Cost = time × cost per hour

Exercise 12D

FUNDAMENTALS

1 Demonstrate your understanding of terms by filling in the missing words and units in the following statements.

a To calculate actual distances using a map's line segment scale:

i Measure the ____ segment scale, in ___.

ii Calculate the scale in km/___ from the line segment scale.

iii The _____ distance in km = ____ distance in __ × scale in __/__.

b Time $= \frac{\square}{\square}$; $t = \frac{\square}{\square}$

c The cost of a journey is the cost per _____ × the number of _____.

Example 10

2 Rob and Mary fly their small plane from Longreach to Birdsville for the annual races. Their plane flies at 320 km/h. Use the Queensland map given previously to complete the following.

a Measure the 200 km line segment scale, in mm, and calculate the scale, in km/mm, to one decimal place.

b Measure the map direct distance, in mm, from Longreach to Birdsville and then convert this map distance to the actual distance.

c Estimate the time it will take Rob and Mary to fly from Longreach to Birdsville.

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3 Using the following map of Australia, determine the direct distance and travel time between each of the two towns listed when given the speed of travel between each place.

a Brisbane – Townsville, 280 km/h
b Alice Springs – Uluru, 85 km/h
c Noosa Heads – Brisbane, 100 km/h
d Hobart – Sydney, 650 km/h
e Perth – Cairns, 620 km/h
f Melbourne – Darwin, 560 km/h

Hint First calculate the map scale in km/mm.

Example 11

4 A private jet costs approximately $4000 per hour of flight time to hire and flies at an average speed of 480 km/h. Use the map of Australia presented in Question **3** to determine the approximate costs for chartering this jet for each of the following journeys.

a Airlie Beach to Canberra
b Broome to Adelaide
c Bundaberg to Snowy Mountains
d Albany to Newcastle
e Melbourne to Sydney
f Brisbane to Sydney

5 Rosco Truckers travel around South East Queensland at a cost of approximately $110/h. If a truck's average speed is 80 km/h, calculate the approximate costs of the following trips, using the map of South East Queensland at the top of the next page.

a Brisbane to Caboolture
b Toowoomba to Ipswich
c Gold Coast to Brisbane
d Dalby to Kingaroy
e Gympie to Maroochydore
f Warwick to Nambour

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APPLICATIONS

SF: –	CF: 6–12	CU: 13, 14

★6 The Queensland train, the Inlander, travels from Townsville to Mt Isa via the towns along the route.

a Using the following map of Queensland, estimate the length of this railway line, given it is around 37% longer than the direct distance from Townsville to Mt Isa via Charters Towers and Cloncurry.

b Calculate the Inlander's arrival time in Mt Isa if it leaves Townsville at 10 a.m. and has an overall average speed of 46.5 km/h for the journey.

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7 Hindley Cruises runs an all-inclusive boat cruise from Cairns to Airlie Beach. Complete the following for a one-way trip on this cruise.

- **a** Using the map of Queensland given in Question **6**, determine the direct distance, in km, from Cairns to Airlie Beach.
- **b** If the ship's operating costs are $584/km, determine the total cost to run this cruise.
- **c** Assuming there are 500 passengers, calculate the minimum price per passenger to cover operating costs.

Example 12

★8 Jay promptly leaves work at Byron Bay at 5 p.m. to visit his mother, who is in the Gold Coast Hospital. Visiting hours are from 5 p.m. until 8 p.m. Using the map of South East Queensland given in Question **5**, determine approximately how long Jay will have visiting his mother. Assume he at drives at an average speed of 90 km/h.

★9 The Adams family are planning a weekend away at Maroochydore. They will leave their home in Ipswich by Friday 4 p.m. and will travel to Maroochydore via Brisbane. Due to Friday afternoon traffic, their average speed is estimated at 80 km/h. Using the map of South East Queensland given in Question **5**, calculate when the Adams family can expect to arrive at Maroochydore.

★10 Use the map of South East Queensland given in Question **5** to complete the following.

Delia is a florist in Toowoomba and needs to make a last-minute delivery to Dalby by 2 p.m. for a wedding. If she leaves at 12.30 p.m. and travels at an approximate speed of 100 km/h, will she make the delivery in time? If yes, how much time will Delia have to spare?

Hint First, find the approximate distance between Toowoomba and Dalby.

★11 Aiden's car has broken down at Nambour. Two towing companies arrive: one that will tow the car to Gympie and one that will tow the car to Caboolture. Gympie Towing costs $9.50 per km and Caboolture Towing costs $10 per km. Use the map of South East Queensland given in Question **5** to determine the approximate distances from Nambour to each of the towns and, hence, determine which company has the cheaper offer and by how much.

★12 Lukas owns a vineyard in the Barossa Valley, South Australia, and is hiring a small plane to fly to Toowoomba, to attend a winemaking conference. The plane's average speed is 280 km/h and it costs $340 per hour of flight time. Using the map of Australia given in Question **3**, calculate how much it will cost for Lukas to fly from the Barossa Valley to Toowoomba and back again.

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PROBLEM-SOLVING

★13 Nigel and Naomi are cotton farmers in Chinchilla. They have booked tickets to a jazz concert in Tewantin for 7 p.m. Saturday. Nigel is a pilot and the couple have their own plane, which flies at 270 km/h.

Nigel and Naomi plan to fly from Chinchilla Airport to Maroochydore Airport and then drive a hire car, driving at an average speed of 70 km/h.

Using the map of South East Queensland given in Question **5**, calculate the latest time that Nigel and Naomi will need to take-off from Chinchilla Airport in order to arrive at the jazz concert half an hour before it starts.

★14 Trevor is living in Adelaide and has a meeting in Ipswich, Queensland. He has chartered a plane from Adelaide that flies at an average speed of 600 km/h, leaving at 8 a.m. in the morning. He has also hired a car at Brisbane airport to drive to Ipswich and will average 70 km/h for this part of his journey.

Using the maps of Australia given in Questions **3** and **5**, calculate the time Trevor should schedule his meeting, given that Adelaide is in a time zone that is 30 min behind Queensland time.

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12E Interpreting distance versus time graphs COMPLEX

LEARNING GOALS

- Identify distances from distance–time graphs when given the time
- Identify speeds from distance–time graphs
- Calculate speeds from distance–time graphs
- Describe journeys from distance–time graphs

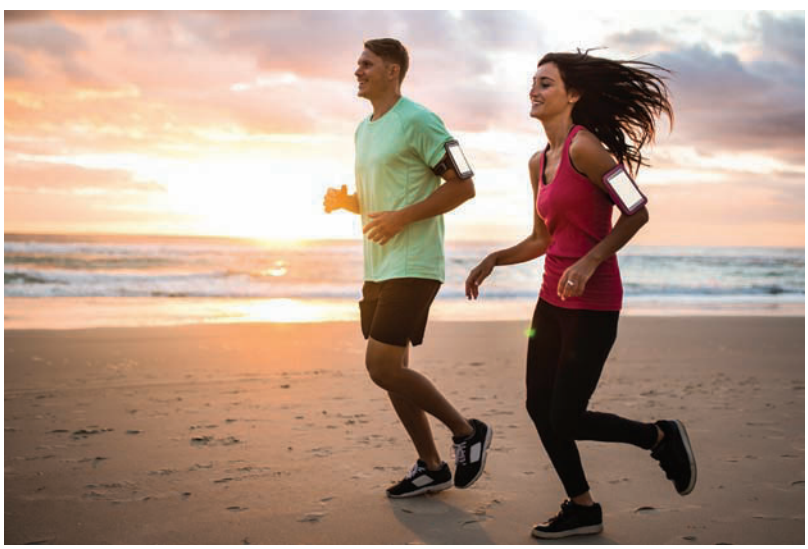
Why do people find it essential to use distance–time graphs?

Distance–time graphs are a pictorial representation of speed. By recording a person's distance over time we are also recording their speed, though not directly, it has to be calculated. On the distance–time graph speed is represented by the slope of the line.

Distance–time graphs are also use to show the motion of vehicles and objects. They are used in science to analyse motion.

In this section, we deal with linear graphs that have line segments which are straight. This means the speeds are constant or average speeds for the different segments of the journey or route. Speed changing over time—acceleration (speeding up) and deceleration (slowing down)—are not are featured in this section. They would result in curved or irregular graph lines.

The distance for a distance–time graph is measured from the starting point, along the route (not the straight line distance to the start). The distance could be measured at regular time intervals or only when the speed changes. Distance–time graphs do not provide any information about the shape of the route—they are not maps. The only direction information provided is whether the motion is away from or towards the starting point.



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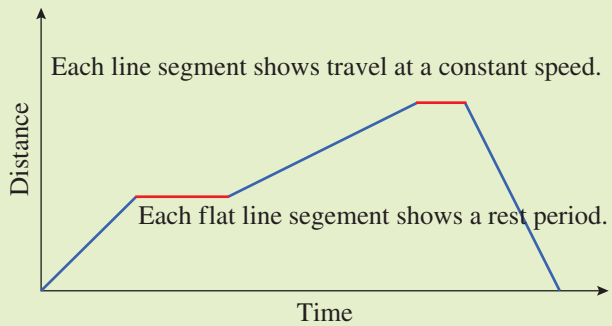
WHAT YOU NEED TO KNOW

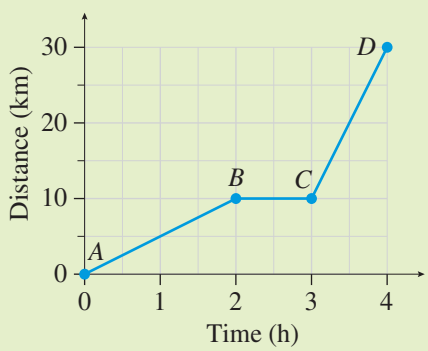
- A **distance–time graph** has distance on the vertical axis and time on the horizontal axis.
- Each plotted point has **coordinates** (time, distance).
- Each straight **line segment** shows a section of a journey travelled at a **constant speed**.



- A horizontal line segment has no distance change; hence, the speed is zero (i.e. the object or person is at rest).
- A line sloping up to the right is the journey away from the starting point (outbound). A line sloping down to the right is the journey back to the starting point (return).
- **Steeper lines** show faster speeds than flatter lines.
- For each line segment:

$$\text{Speed} = \frac{\text{distance travelled}}{\text{time taken}}$$

  - For example: A bicycle journey is shown in the following distance–time graph.



Line segment AB:
Speed $= \frac{10 \text{ km}}{2 \text{ h}} = 5$ km/h

Line segment BC:
Speed $= 0$

Line segment CD:
Speed $= \frac{20 \text{ km}}{1 \text{ h}} = 20$ km/h

- When drawing a distance–time graph:
  1. Identify the total distance and create the vertical axis scale.
  2. Identify the total time and create the horizontal axis scale.
  3. Plot the given points and join them with a ruler to create line segments.

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Example 13 Interpreting a distance–time graph

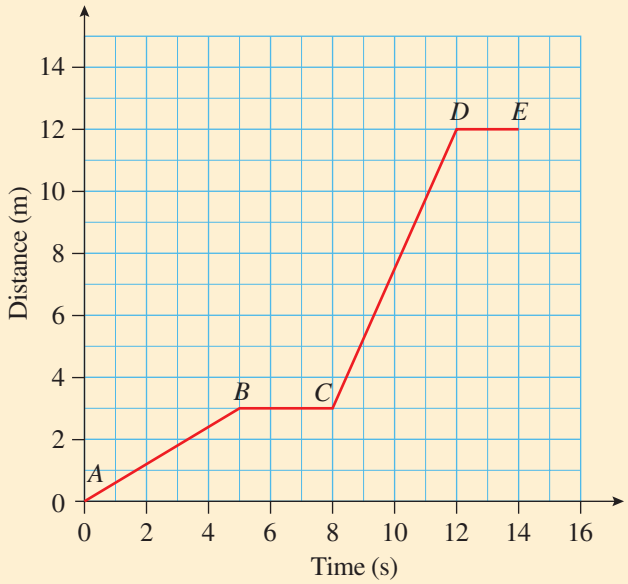
Refer to the graph shown at right and complete the following.

a What is the distance travelled in the first 5 s?

b What is the speed of the journey from *A* to *B*?

c Which part of the journey has the longest rest period?

d Which part of the journey has the fastest speed?



WORKING	THINKING
a Distance = 3 m	Draw a vertical line from the axis 'Time' at 5 s up to the graph, and then a horizontal line across to the distance axis.
b Speed = distance ÷ time = 3 m ÷ 5 s = 0.6 m/s	Use the formula to find the speed from *A* to *B*.
c from *B* to *C*	Identify the longest horizontal line.
d from *C* to *D*	Identify the steepest line segment.

Example 14 Interpret the distance–time graph in a real-world situation

The first 14 s of Alice's movements during a netball match are shown in the graph in **Example 13**. Describe, in words, Alice's movements for the first 14 s of her game.

WORKING	THINKING
Alice ran her slowest for the first 5 s and then rested for 3 s before running her fastest for the next 4 s and then rested for the last 2 s.	Using the slope of the line, identify when Alice was running fast, slow and not running at all. Use that information to describe her run in words.

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Exercise 12E

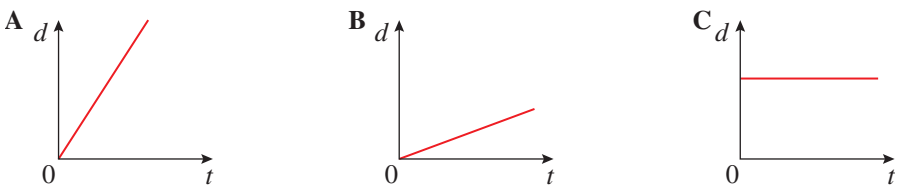
FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words and units in the following statements.

- **a** A distance–time graph has distance on the _____ axis and time on the _____ axis.
- **b** Each plotted point has coordinates (_____, _____).
- **c** Each _____ line segment shows a journey section travelled at a _____ speed.
- **d** For each line segment, speed = _____ ÷ _____.
- **e** A horizontal line segment shows the speed is _____.
- **f** Steeper lines show _____ speeds than flatter lines.
- **g** When drawing a distance–time graph:
  - **1** Identify the total _____ and create the vertical axis scale.
  - **2** Identify the total _____ and create the horizontal axis scale.
  - **3** _____ the given points and join them with a ruler to create line _____.

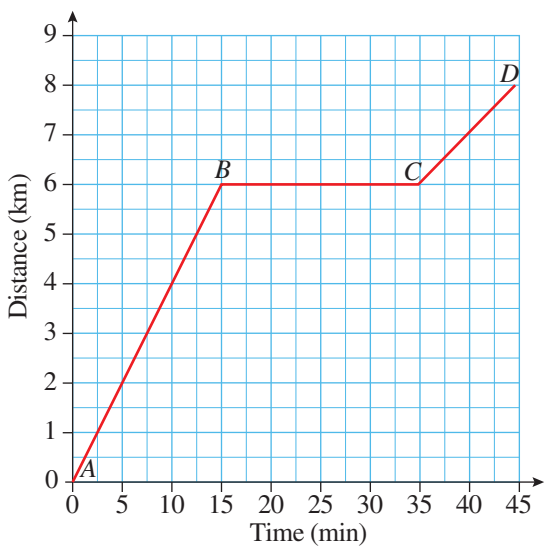
Example 13

2 Shown are distance–time graphs, where the distance is d and the time is t. Match the descriptions **a** to **c** with the graphs **A** to **C**.



a fastest speed **b** slowest speed but not at rest **c** stopped

3 Refer to the graph shown and complete the following.



- **a** What is the distance travelled in the first 15 min?
- **b** Calculate the speed of the journey from A to B.
- **c** What is the distance travelled from B to C?
- **d** Calculate the speed of the journey from B to C.
- **e** What is the distance travelled from C to D?
- **f** Calculate the speed of the journey from C to D.

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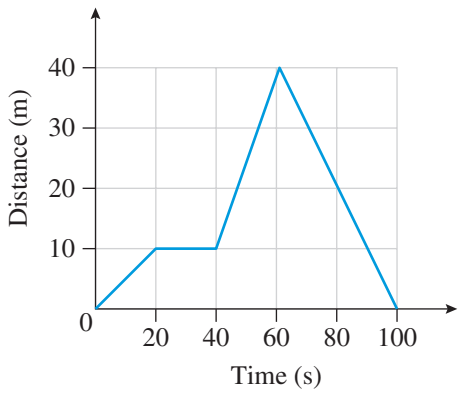
APPLICATIONS

SF: – | CF: 4–10 | CU: 11, 12

Example 14 ★4 Kemar and Ramon are Commonwealth Games 100 m athletes. If Kemar takes 10.5 s and Ramon takes 11 s to complete the race, construct a graph to illustrate the race.

★5 Jenni watches her hen in the backyard and keeps track when she opens the chicken coop. She records its movements and displays them on a graph, shown below. Describe, in words, the hen's movements.

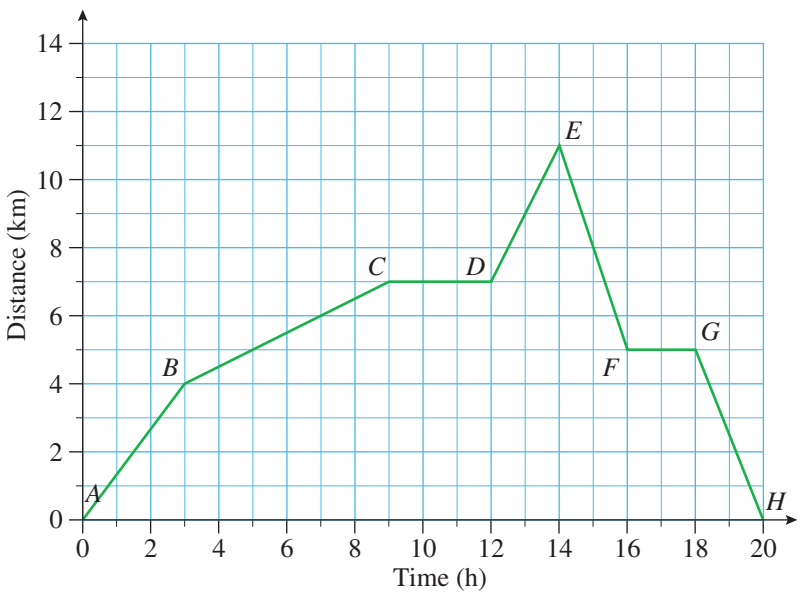


★6 The graph shown describes Kim's 12 km walk around Mt Tibrogargan. Identify which part of her journey Kim:

a was at rest the longest

b walked at her slowest speed but was not at rest

c walked at her fastest speed



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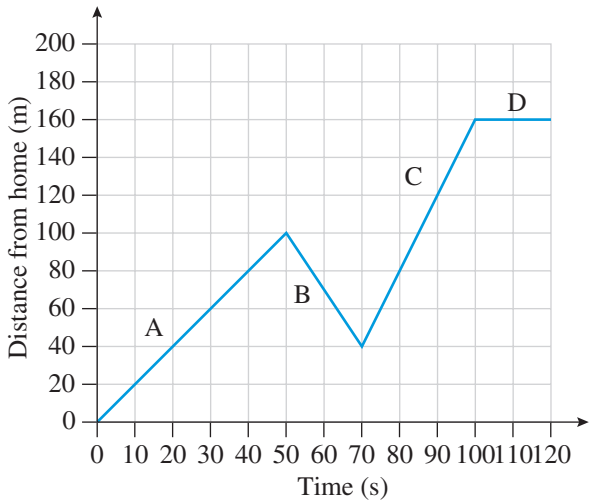
★7 Ken is riding his bike around his neighbourhood. The graph below illustrates his ride for the first 2 min. Identify which part of his journey Ken:

a was at rest

b cycled at his slowest speed

c cycled at his fastest speed

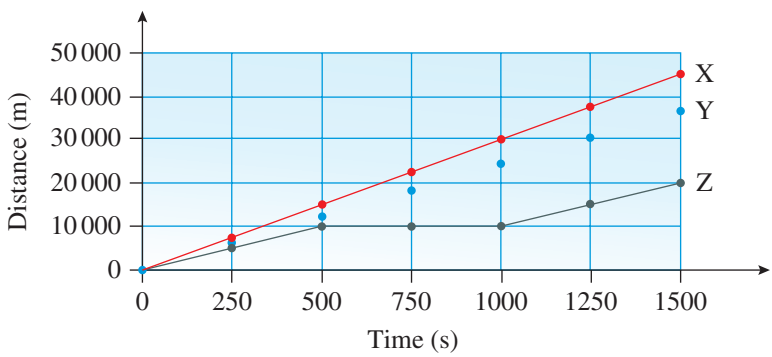


★8 Draw a distance–time graph to show the following information about Lana's run.

- Starting from her home, Lana runs 3 km in 12 min.
- She then has a 5 min rest.
- She then runs 4 km farther from home, taking 15 min.
- After a 10 min rest, Lana runs home in 21 min.

★9 Illustrate Aamir's journey with a time–distance graph.
Aamir drives 120 km in 2 h. He stops for lunch for 30 min, then drives 240 km in the next 3 h. After another 30 min break, Aamir drives a further 400 km in 4 h.

★10 The graph shows three prototype vehicles, labelled X, Y and Z. The company decides to produce and market the fastest vehicle. From the graph, determine the fastest vehicle, giving reasons for your decision.



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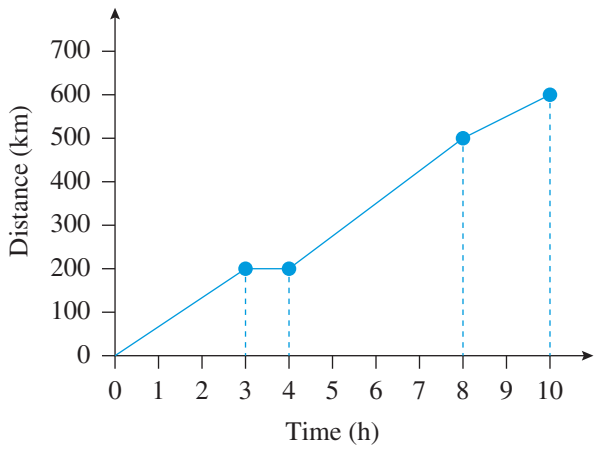
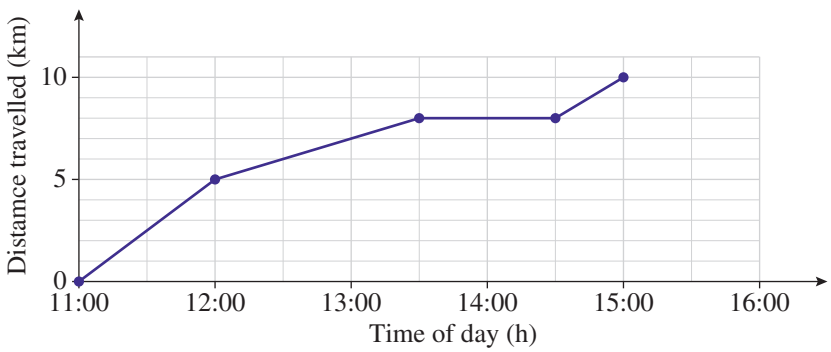
PROBLEM-SOLVING

★11 Chen is driving and his journey is illustrated by the graph shown. Using your imagination and the information from the graph, write a story describing Chen's car trip.



★12 Using your imagination, write a short story that could be illustrated by the following graph.



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Problem-solving and modelling task

HOLIDAY

Background: Travel websites particularly for flights provide accessible time and cost data, while online mapping applications provide distance data, enabling speed to be calculated.

Task: Your task is to plan a return trip by plane in Australia, to a minimum of two places and then returning home. You are to use a travel website to plan your journey. For each flight you will need to identify or calculate the flight distance, the flight (duration) time, the speed of the plane and the cost of the flight.

Also, for each flight you will need to use the cost and journey time to calculate the cost per hour you are paying.

To conclude, you will identify the fastest and cheapest leg of your trip. To complete this task, follow the problem-solving workflow diagram below and use the steps listed as a guide.

Stage 1: Formulate

1 Decide which travel site you will use.
2 Decide to which destinations you will be flying.

Stage 2: Solve

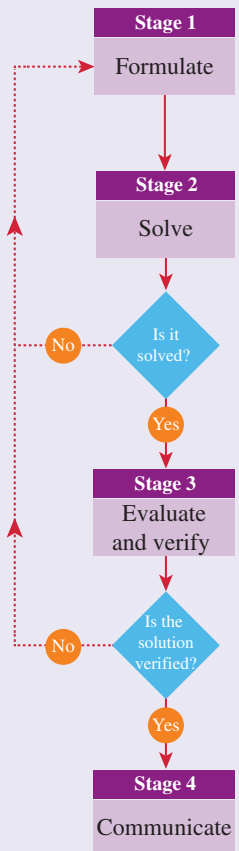
3 Research the distance between your destinations using Google Maps.
4 Use the travel website to identify the travel time between each of your destinations and the cost of the flight.
5 Calculate the plane's speed for each flight.
6 Calculate the cost per hour of each leg of your journey.

Stage 3: Evaluate and verify

7 Compare the speed of each flight and its flying costs per hour.
8 Identify which flight is the cheapest and quickest.

Stage 4: Communicate

9 Communicate your findings in a short report, referring to your calculations of cost and speed.



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Puzzle

The Bugatti Veyron used to be the world's fastest car up until the 6th November 2017, when another car hit a top speed of 284.5 miles/h or 458 km/h. Solve the puzzle below to find out the name of the World's Fastest Car on that date and the country in which it was made.

Solve the following questions and use each answer to fill in the question letter above the answer in the grids below.

K Calculate the average speed of a 42 km marathon run in 3.5 h.

O Calculate the total kilojoules in a 600 mL bottle of honey sauce if it has 125 kJ per 100 mL.

E Using the chart presented in **Exercise 12A**, Question **4**, calculate the calories used by a 90 kg person hiking with a 10 kg load for 30 min. Give your answer to two decimal places.

W Julia travelled 450 km in 5 h. Using the appropriate formula, calculate the speed at which she travelled.

R Calculate the distance travelled if Toby drove at 72 km/h for 6 h.

N Calculate, to one decimal place, the amount of time Alyssa spent travelling if she flew 1650 km at 420 km/h.

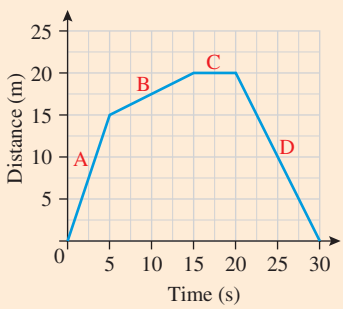
A Imogen ran 200 m in 53 s. Calculate how fast she ran, to one decimal point.

I Michael rode his bicycle for 12.5 h at 36 km/h. Calculate how far Michael cycled.

G Using the map of Australia from **Exercise 12D**, Question **3**, estimate the travel time from Karratha to Townsville if you are flying at 660 km/h.

D Use the information in the graph at right to determine how long the person was at rest.

S Use the information in the graph to the right to calculate the speed of section A.



12	750	396.9	3.9	450	4.4	3	396.9	4.4	4.4

3.8	4.4	396.9	432	3.8		432	3

3	90	396.9	5	396.9	3.9

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Chapter checklist

☐ I can understand different units of energy and can calculate energy from food labels.

1 If chicken nuggets have 782 kJ per 100 g serving, calculate the total kilojoules in a 750 g box.

2 Using the table given, calculate the calories burned by a 67 kg person cycling for 1.5 h.

Exercise energy chart Calories for 30 min of exercise	
Activity	**Energy used (cal/kg/30 min)**
Cycling at 15 km/h average	2.76
Hiking with 15 kg load	5.18
Hiking, no load	3.42
Jogging at 8 km/h average	4.08
Rowing machine	3.97
Running at 13 km/h average	6.72
Skipping rope	6.28
Soccer	4.30
Stair climbing	3.09
Swimming at 25 m/min	2.65
Walking at 5 km/h average	1.76

☐ I can calculate average speed and determine the appropriate units of speed.

3 Describe the speed of an athlete competing in the 400 m event, choosing the appropriate unit of speed from: km/h, m/s, m/h or km/year.

4 Calculate the average speed of a sloth that travels 32 m in 60 s.

☐ I can calculate speed, distance or time from the formula speed = distance/time.

5 Using the formula, calculate the speed when travelling a distance of 720 km in 10 h.

6 Using the formula, calculate the distance when travelling at a speed of 26 m/s in 37 s.

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Chapter checklist

7 Using the formula, calculate the time taken to travel a distance of 378 km at 89 km/h.

8 Nazeem drove 230 km at 92 km/h. If she left home at 3 p.m., at what time did she arrive at her destination?

☐ I can calculate time and costs for a journey, from distances estimated from maps when given a travelling speed.

9 Use the map of Australia given in **Exercise 12D**, Question **3**, to solve the following questions.

a Estimate the time taken to travel from Geraldton to Alice Springs when travelling at 420 km/h.

b Connie chartered a private jet, costing $2160 per hour of flight time. If the jet travels at 440 km/h, use the map to calculate the approximate cost of flying from Hobart to the Barossa Valley.

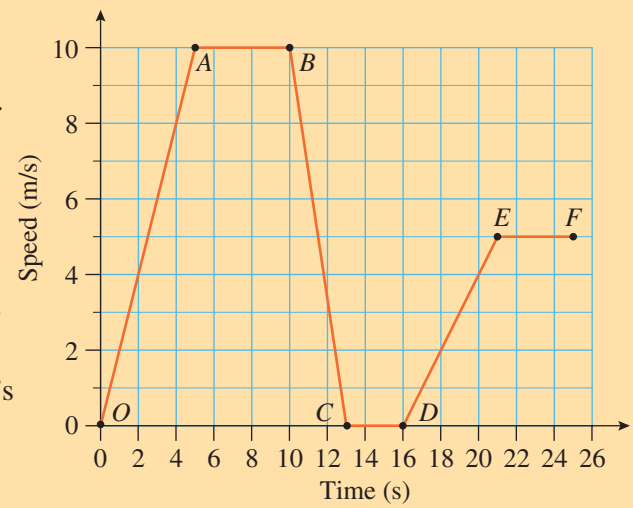
☐ I can interpret distance–time graphs.

10 Use the information in the graph shown to complete the following.

a Name the sections in which the object is at rest.

b Name the section in which the object has the fastest speed.

c Calculate the object's speed from D to E.



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Chapter review

All questions in the Chapter Review are assessment-style.

Simple Familiar

Section 12A

1 Yasmin decides she is going to eat only Sugar Sweet Circle Cereal for the day, which has a nutritional label that reads 520 kJ per 100 g. Calculate how many grams she can have for the day if her recommended kilojoule daily allowance is 8000 kJ.

2 Leon, who weighs 86 kg, eats all of a 250 g block of chocolate, which has a nutritional label indicating 232 calories per 100 g. Use the table's information to calculate how long Leon will have to skip to burn the calories consumed.

Exercise energy chart Cal/kg of body mass per 30 min of exercise	
Activity	**Energy used (cal/kg/30 min)**
Cycling at 15 km/h average	2.76
Hiking with 15 kg load	5.18
Hiking, no load	3.42
Jogging at 8 km/h average	4.08
Rowing machine	3.97
Running at 13 km/h average	6.72
Skipping rope	6.28
Soccer	4.30
Stair climbing	3.09
Swimming at 25 m/min	2.65
Walking at 5 km/h average	1.76

Section 12B

3 Vlad must drive from Dalby to Brisbane to catch a flight departing at 10:30 a.m. The distance to the airport is 210 km and he drives at an average speed of 84 km/h. Calculate the latest time Vlad must leave Dalby if he must arrive 45 min before the departure time to allow for check-in.

4 Willow lives 750 m from her local train station. If she has only 5 min to catch the train, calculate the speed, in m/s, she must run.

Section 12C

5 Laiza participated in a charity car rally, driving 500 km in 5 h 36 min. Calculate her overall average speed, to one decimal place.

6 Ibrahim ran west from his home for 45 min at a speed of 9.2 km/h. Calculate the distance he must travel to get back home.

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7 Natalia must get to her grandmother's house by 5 p.m. If Natalia rides her bike at 15 km/h and her grandmother lives 20 km away, calculate when she must leave home to arrive at her grandmother's house on time.

8 Adrian drove 476 km at a speed of 94 km/h. If he left home at 7 a.m., calculate when he arrived at his destination.

9 Jessica runs the 800 m event at 4.2 m/s and Nikki runs the same event at 4.1 m/s. Calculate the time difference between the two girls at the finish line.

10 Osman leaves home at 11 a.m. and drives at an average speed of 88 km/h until 2:45 p.m. Calculate how far he has travelled in that time.

Complex Familiar

Section 12E

11 Hayley walked 8 km in 2 h. She stopped for lunch for 30 min and then walked a further 4 km in the next 1.5 h. After stopping for 30 min for a coffee, she walked a further 10 km in 4 h. Illustrate Hayley's journey with a distance–time graph.

Section 12D

Use the map of Canada given to complete questions **12, 13** and **15**.

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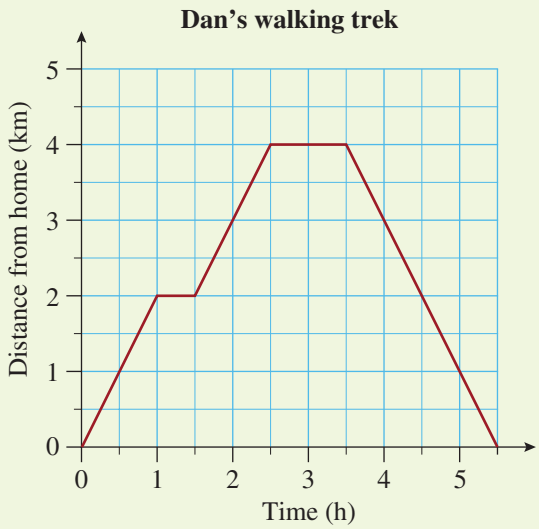
12 Kyle hires a private plane to fly from Montreal to Calgary, which costs $1720 per hour. If the plane flies at 480 km/h, calculate the approximate cost of Kyle's flight.

13 Kelly takes a taxi from Regina to Winnipeg. The taxi costs $64 per hour and travels at an average speed of 88 km/h. From the map, find an approximate direct distance and, hence, calculate the cost of Kelly's journey.

Complex Unfamiliar

14 Dan went on a walking trek, as shown in the graph. Using your imagination and the information from the graph, write a story describing his trek.



15 Use the map of Canada to complete this question. Merlin has a deer farm and lives near Edmonton. He takes a limousine from Edmonton to Calgary and then takes a chartered flight to Toronto, to attend an important business dinner at 7 p.m. The limousine, which costs $82 per hour, travels at an average speed of 80 km/h directly from Edmonton to Calgary, and the plane, which costs $1600 per hour, flies at 420 km/h. From the map, find the approximate distances and then calculate:

a when Merlin should leave to make it to the business dinner on time

b how much the journey will cost

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13 Census and surveys

Maths for a chef: James Chudleigh

James Chudleigh has been a chef for 8 years. He started a school-based apprenticeship four days a week at his local Tavern midway through Year 12 and completed his apprenticeship at a surf club in 2010. He now works as a chef in a boarding school, where they prepare hot meals for 200 students and staff three times a day and cater functions for up to 500 people.

Tell us a bit about your job. What does a typical day look like?

I begin my shift by liaising with other cooks from the previous shift about where they are up to. We prepare a worksheet for the day of tasks that need to be completed and assign who in the team is going to be responsible. Once we finish preparing lunch, we begin preparing for dinner.

What do you like about being a chef?

I like to cook and eat good food. I enjoy working with a team of great people. There is a lot of energy in a kitchen and it is satisfying to produce a meal that is enjoyable and brings people together.

What maths did you study at school?

I started in Maths A and B in Year 11 but once I began my apprenticeship I dropped back to Trade and Business Mathematics, which I found more relevant to my trade.

How do you use maths in your job? Could you give some examples?

There are lots of multiplications to get a recipe to serve 200 people. We also use maths when applying recipes, for conversions of ounces to grams and cup measures. We measure and count as we plate up meals for portion control. Feedback from the students is important when putting a menu plan together, so that food produced is equal to food eaten and meets healthy guidelines.

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In this chapter

13A Investigating a census **[complex]**
13B Surveys and simple random sampling **[complex]**
13C Systematic sampling **[complex]**
13D Stratified sampling
13E Identifying target populations
13F Questionnaire design principles
Problem-solving and modelling task
Puzzle
Chapter Checklist
Chapter Review

Syllabus reference

Unit 2 Topic 3 Subtopic Census (3 hours)

In this subtopic, students will:

- investigate the procedure for conducting a census
- investigate the advantages and disadvantages of conducting a census **[complex]**.

Unit 2 Topic 3 Subtopic Surveys (5 hours)

In this subtopic, students will:

- understand the purpose of sampling to provide an estimate of population values when a census is not used
- investigate the different kinds of samples **[complex]**
- investigate the advantages and disadvantages of these kinds of samples **[complex]**.

Unit 2 Topic 3 Subtopic Simple survey procedure (4 hours)

In this subtopic, students will:

- identify the target population to be surveyed
- investigate questionnaire design principles, including simple language, unambiguous questions, consideration of number of choices, issues of privacy and ethics, and freedom from bias **[complex]**.

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Pre-test

1 Classify each of the following data as either categorical or numerical, and give two possible survey responses.

a money spent in canteen
b favourite sauce
c age (years)
d preferred transport mode
e favourite music genre
f number of monthly visits to cinema

2 Why might someone wish to compile each of the datasets in Question **1**?

3 A high school with 100 students conducts a survey asking students what is their commute time from school to their home, in minutes. The survey receives five responses: 6, 10, 10, 15, 10.

a Find an estimate for the average of the data.
b Does the data represent the other 95 students' commute times? Explain why/why not.

After a few days, the survey receives more responses:
20, 35, 25, 30, 28, 45, 38, 31, 25, 3, 27, 32, 17, 13, 36.

c i Including the original data, find an estimate for the average of the new dataset.
ii Compared to part **a**, how has the average changed?
d Would the extra responses be a better representation of the other students' commute times? Explain why/why not.
e Group the responses in appropriate ranges and display them in a dot plot.

4 A survey is done to compile Year 11 students' test scores. Students can choose whether or not they wish to participate. The survey receives the following 10 responses.

90 85 91 92 75 81 83 94 100 79

a Display the results in a grouped frequency table.
b Would a student with a lower test score willingly participate in this survey?
c What problems does this survey have? (Don't forget to use your answer from part **b**.)

5 The number of people using a train station on weekdays is recorded for 20 days:

111, 150, 123, 143, 129, 136, 109, 112, 114, 113,
119, 128, 149, 146, 205, 195, 147, 131, 135, 125

a What type of data is this?
b Identify the lowest and highest number of commuters in a day.
c Give an estimate of the average number of commuters on a weekday.
d Display the data in any appropriate method (e.g. table, dot plot, etc.).
e Are there any outliers in this data? What are the possible explanations for them?
f Suppose you wish to estimate the number of people using the train station on weekends. Is using the weekday data appropriate for this? Explain your reasoning.

A link to a HOTmaths lesson is provided in the Interactive Textbook to revise this topic.

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13A Investigating a census COMPLEX

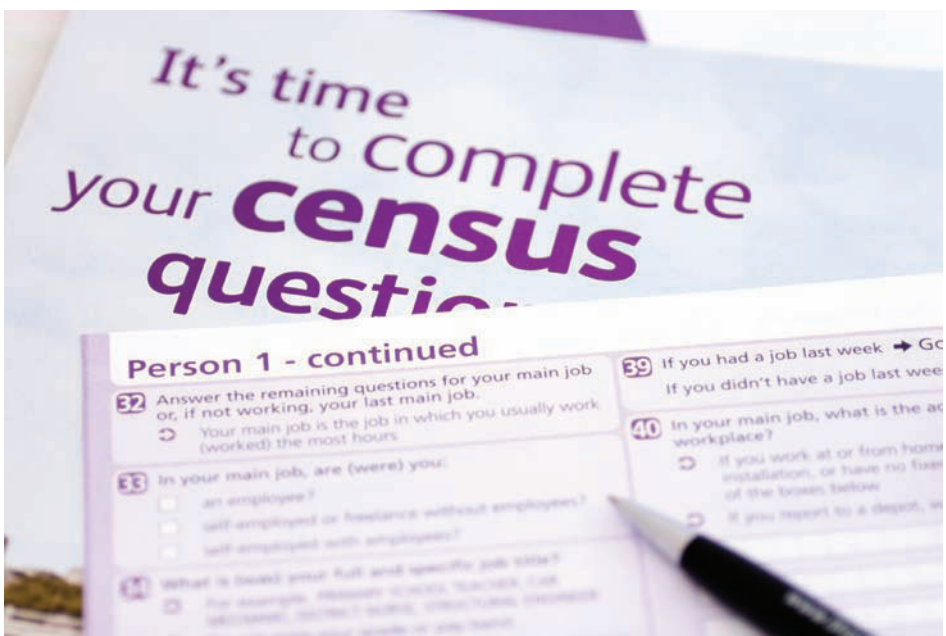
LEARNING GOALS

- Analyse how census data can be used by the government
- Investigate some aspects of the Australian national Census of Population and Housing including an outline of the procedure for conducting the census.
- Investigate the advantages and disadvantages of conducting a census

Why is a census essential?

Censuses have been conducted by governments all over the world, dating back over 6000 years. A census determines the number of inhabitants in a country, various characteristics of the population, tells us about our way of life and helps us plan for the future.

Australia has conducted a national census every 5 years since 1911. According to the Australian Bureau of Statistics, census data 'is used to distribute government funds and plan services for your community – housing, transport, education, industry, hospitals and the environment'.


It's time
to complete
your census
Person 1 - continued
Answer the remaining questions for your main job or, if not working, your last main job.
Your main job is the job in which you usually work (worked) the most hours
In your main job, are (were) you:
If you had a job last week
If you didn't have a job last wee
In your main job, what is the a
workplace?

On the evening of Tuesday 9 August 2016, Australians had, for the first time, the option of completing the census online.

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WHAT YOU NEED TO KNOW

- A **census** can be conducted on any type of **population** (e.g. people, dwellings, vehicles, livestock, etc.). We will limit ourselves to a census of human populations.
- A census is an official count of the *entire* population of a country.
- A census also collects data about each member of the entire population.

The Australian national Census of Population and Housing

- The Australian Bureau of Statistics (ABS) is responsible for organising this census.
- All members of the population complete the census form on the same day.
- This census is conducted every 5 years and is compulsory. However, some of the questions are optional.
- Until 2016, only the paper version of the census form was used, which required about 40 000 people to personally deliver and collect it from every dwelling in Australia.
- The census can now be completed either online or using the paper form.
- It provides data about each person staying in the dwelling on that night.
- The information requested includes:
  - Your name, age, gender, marital status, ancestry and religion
  - Whether you are Aboriginal or Torres Strait Islander
  - Your usual place of residence; where you lived 1 year ago; and where you lived 5 years ago
  - Your place of birth and if you are an Australian citizen
  - If you need assistance with self-care, communication and mobility
  - Your education qualifications, employment status and annual income
  - Where you work, what you do, and how many hours you work per week
  - Details of unpaid work you may have done
- It also provides information about the dwelling such as: How many bedrooms? Do the occupants own it? Does it have internet? How many cars are present that night?

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Example 1 Analysing how census data can be used by the government

a Explain how Australian population census statistics are used by the government for:
- **i** electoral purposes
- **ii** government funding

b Identify a community need that is revealed by the following 2016 census statistics.
- **i** The median age for Aboriginal and Torres Strait Islander population is 23 years compared to 38 years for the rest of the population.
- **ii** 47.4% of Australian families have both partners employed in either full-time or part-time work.

WORKING	THINKING
a i Population statistics are needed for the regular review of the electoral boundaries for House of Representative seats.	Politicians need to represent all regions fairly in our democracy. Each electorate should have close to an equal number of voters.
ii Population statistics are needed to determine the fair distribution of the Goods and Services Tax (GST) revenue to States and Territories.	States receive GST funds distributed by the federal government in proportion to the population of each State. These funds help to run our public schools, hospitals and other services.
b i Aboriginal and Torres Strait Islander population may require more medical assistance and also educational services.	The 15-year gap in median age indicates that the Aboriginal and Torres Strait Islander population is younger than Australia's overall population. This may mean a lower life expectancy and a higher proportion of children.
ii Working parents need relevant services for support, such as an increased need for childcare.	Politicians must keep up with the needs of our community when putting policy together.

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Exercise 13A

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in the following statements.

- **a** A census is an official count of an _____ population.
- **b** A census determines the _____ of inhabitants in a country, various characteristics of the population, tells us about our way of life and helps us _____ for the future.
- **c** Census data is used to distribute government _____ and plan _____ for your community.

APPLICATIONS

SF: 2–3	CF: 4–6	CU: –

Example 1

2 **a** Explain how Australian population census statistics are used by the government for:

- **i** electoral purposes
- **ii** government funding

b Explain how the Australian government might use a census count of families with both parents working.

Hint In a democracy, the electorates have close to equal numbers of voters.

★3 Investigate and describe the steps in the procedure for conducting the Australian national Census of Population and Housing.

★4 Investigate and describe two advantages and two disadvantages of conducting a census.

★5 Explain why it would be useful for the government to know the following statistics collected from 2016 Census data.

- **a** Management and Commerce is the most popular field of study in Australia.
- **b** 56% of women in Australia are employed, compared with 65% of men.
- **c** Of the employed population aged 20–64 years, those with a non-school qualification (i.e. a degree, diploma or certificate) had a higher median personal income than those without a qualification.
- **d** 35% of Queensland Aboriginal and Torres Strait Islander people are under 15 years of age.

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6 A selection of questions from the 2016 Census are given in the box at right.

- **a** Which questions collect numerical data?
- **b** What is the focus of Census questions 11–15?
- **c** Why is it useful for the ABS and the federal government to know the information collected in Census questions 11–15?
- **d** What is the focus of Census questions 16 and 17?
- **e** Why is it useful for the ABS and the federal government to know the information collected in Census questions 16 and 17?
- **f** Answering Census question 19 is optional. Why would this be an optional question?
- **g** What is the focus of Census questions 20–22?
- **h** Why is it useful for the ABS and federal government to know the information collected in Census questions 20–22?
- **i** What is the focus of Census questions 34–44?
- **j** Why is it useful for the ABS and the federal government to know the information collected in Census questions 34–44?
- **k** What is the focus of Census question 45?
- **l** Why is it useful for the ABS and the federal government to know the information collected in Census question 45?

ABS CENSUS QUESTIONS

11 Is the person an Australian citizen?
12 In which country was the person born?
13 In what year did the person first arrive in Australia to live here for one year or more?
14 In which country was the person's father born?
15 In which country was the person's mother born?
16 Does the person speak a language other than English at home?
17 How well does the person speak English?
18 What is the person's ancestry?
19 What is the person's religion?
20 Does the person ever need someone to help with, or be with them for, self care activities?
21 Does the person ever need someone to help with, or be with them for, body movement activities?
22 Does the person ever need someone to help with, or be with them for, communication activities?
34 Last week, did the person have a job of any kind?
35 In the main job held last week, was the person:
Working for an employer?
Working in own business?
36 Was the person's business:
Unincorporated?
Incorporated (e.g. Pty Ltd)?
37 Does the person's business employ people?
38 In the main job held last week, what was the person's occupation?
39 What are the main tasks that the person usually performs in that occupation?
40 For the main job held last week, what was the employer's business name?
41 For the main job held last week, what was the person's workplace address?
42 What best describes the industry or business of the employer at the location where the person works?
43 What are the main goods produced or main services provided by the employer's business?
44 Last week, how many hours did the person work in all jobs?
45 How did the person get to work on Tuesday, 9 August 2016?

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13B Surveys and simple random sampling COMPLEX

LEARNING GOALS

- Determine when a census or a survey is appropriate
- Understand the purpose of sampling
- Investigate and understand a simple random sampling procedure
- Investigate and understand self-selecting surveys
- Investigate the advantages and disadvantages of simple random samples and self-selected samples

When are surveys essential?

A census is very expensive and time consuming to conduct. A survey samples a smaller group than the entire population. A good quality survey can provide an accurate estimate of population characteristics and is a lot faster and cheaper to undertake.

A survey is the process of gathering information from a small group, known as a sample.

WHAT YOU NEED TO KNOW

- A **census** is an official count of an *entire* population.
- A **survey** is the process of gathering information from a small group, known as a **sample**, from within a population.
- The *purpose* of sampling is to gather data about the population. Information from the sample is used to estimate the characteristics of the population, without the need to survey the entire population.
- According to the ABS, the *advantages* of a survey are:
  - Costs would generally be lower than those for a census.
  - Results may be available in less time.
  - If good sampling techniques are used, the results can closely represent the features of the actual population.
- The ABS advise that the *disadvantages* of a survey are:
  - Data may not be representative of the total population, particularly when the sample size is small.
  - As data is collected from a subset of units (e.g. people) and inferences are made about the whole population, the data is subject to 'sampling' error.

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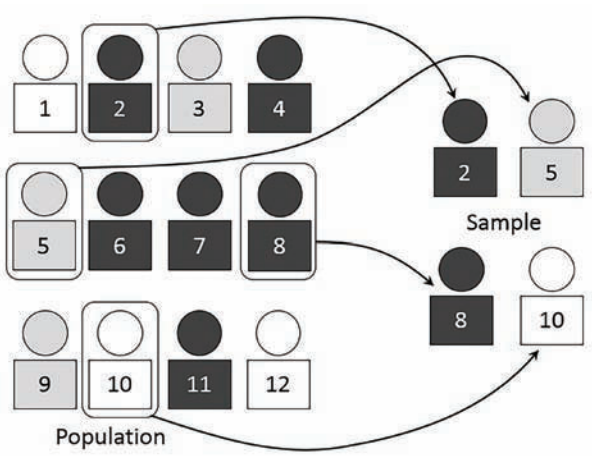
- A decreased number of units will reduce the detailed information available about subgroups within a population.

We will look at **four sampling techniques** in this chapter:

Simple random samples (Section 13B)
Self-selected samples (Section 13B)
Systematic samples (Section 13C)
Stratified samples (Section 13D)

- In a **simple random sample**, all members of a population have an equal chance of being selected for the survey.
  - Method: members are selected from a numbered list using random numbers until the desired sample size is achieved.
  - Advantages: easy to conduct; high chance of achieving a good representative sample.
  - Disadvantages: identifying all members of the population can be difficult; contacting members of the sample can be difficult.
- In a **self-selected sample**, anyone who wants to participate answers the question asked. For example, when a cricket app asks viewers to nominate which Ashes Test Match was their favourite for the summer.
  - Method: a question is posed by a TV program, app, social media page or newspaper and the sample consists of people who choose to respond.
  - Advantages: very easy to conduct and participants are willing to be involved.
  - Disadvantages: can be very biased as the people who respond may be from similar groups, and people can vote multiple times.



In a simple random sample, all population members have an equal chance of being selected.

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Example 2 Choosing between a census and a survey

In the following situations for gathering information:

i determine whether it is better to use a census or a sample

ii explain the main reason for your choice.

a marking the roll in Maths class

b determining the length of time a brand of light bulb lasts

c testing the fire extinguishers at school

d determining the amount of time spent on social media by Year 11 students at your school

WORKING	THINKING
a i census	Every student in the class must be counted.
ii Every student needs to be checked that they are present or not.	
b i survey	Testing each bulb until it fails means every bulb is destroyed by the testing process!
ii It is very expensive and time consuming to test all bulbs.	
c i census	For safety reasons, all the fire extinguishers would need to be tested.
ii It is against the law to have a faulty fire extinguisher.	
d i survey	It can be time consuming to survey the entire Year 11 cohort and the result may be the same as that from a sample.
ii A fair sample will provide a good estimate, and it is faster to organise and collate results.	

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Example 3 Selecting a simple random sample

Mrs Dunsdon wishes to select five students from her home room class to participate in a student satisfaction survey about the food at the tuckshop. The students in her class are:

Harrison	Sapphire	Kiara	Ainsleigh	Oscar
Saxon	Sophie	Dougal	Eileen	Theo
Dominic	Angus	Neve	Douglas	Izak
George	Sam	Lara	Tom	Michelle
Stuart	Laura	Darcy	Arun	Lily

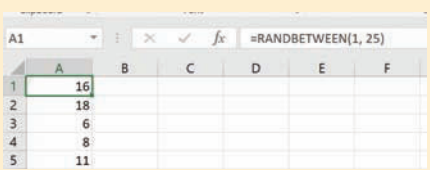
a Assign the numbers 1–25 to the students in the class.
b Use Excel to generate five random numbers.
c Use your random numbers to select five students for the survey.
d Girls' names are written in orange. Calculate the fraction of the class that are girls.
e Calculate the fraction of your sample that are girls.
f Determine whether your sample is a suitable representation of the class.
g Identify some advantages and disadvantages of Mrs Dunsdon's random sampling method for discovering this school's student satisfaction level of tuckshop food.

WORKING

a

1 Harrison	6 Sapphire	11 Kiara	16 Ainsleigh	21 Oscar
2 Saxon	7 Sophie	12 Dougal	17 Eileen	22 Theo
3 Dominic	8 Angus	13 Neve	18 Douglas	23 Izak
4 George	9 Sam	14 Lara	19 Tom	24 Michelle
5 Stuart	10 Laura	15 Darcy	20 Arun	25 Lily

b



THINKING

Work your way down the class list and number students in order.

Type =RANDBETWEEN(1, 25) in your first cell to generate a random number between 1 and 25. Fill down to generate a total of five *different* random numbers.

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WORKING | **THINKING**

c Select the sample.

Match the random numbers to your class list.

1 Harrison	6 Sapphire	11 Kiara	16 Ainsleigh	21 Oscar
2 Saxon	7 Sophie	12 Dougal	17 Eileen	22 Theo
3 Dominic	8 Angus	13 Neve	18 Douglas	23 Izak
4 George	9 Sam	14 Lara	19 Tom	24 Michelle
5 Stuart	10 Laura	15 Darcy	20 Arun	25 Lily

Mrs Dunsdon has selected Ainsleigh, Douglas, Sapphire, Angus and Kiara for the survey.

d Fraction (class) girls $= \frac{10}{25} = \frac{2}{5}$

Fraction girls $= \frac{\text{number of girls}}{\text{total number of students}}$

e Fraction (sample) girls $= \frac{3}{5}$

Fraction girls $= \frac{\text{number of girls}}{\text{total number of students}}$

f This sample is not a good representation of the population. $\frac{2}{5}$ of the class are girls, so the sample should also have two girls but it has three girls.

The class has $\frac{2}{5}$ of students that are girls. Ideally, the sample should have the same fraction of girls if the sample is to be a good representation of the population.

g Advantages: It is a simple procedure and fast to complete.
Disadvantages: It is a very small sample and might include students who don't use the tuckshop. Also, the sample is only from one class, not the whole student population.

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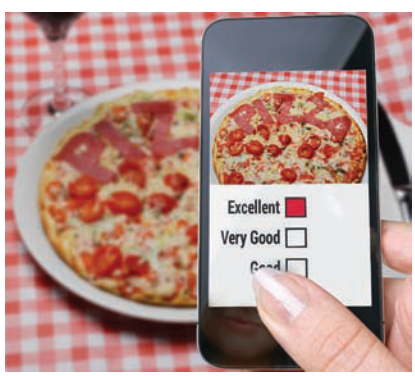
Example 4 Analysing a self-selecting survey

A pizza shop puts a survey on its Facebook page. It says, 'Take our survey! pizzapi.com.au/survey For every 10 responses we get, we'll give away one FREE PIZZA! The survey should take you less than 10 minutes to complete. Your feedback will help make us even better!' A total of 261 people liked the post and 23 people shared it.

This is an example of a self-selecting survey.

a Who is likely to respond to the survey?
b Explain whether the responses be a suitable cross-section of people who eat pizza.
c Consider whether the data gained be useful.
d Identify some advantages and disadvantages of this self-selecting survey.

WORKING	THINKING
a People who follow this pizza shop on Facebook will be the only people able to respond.	
b No, as other pizza eaters and customers who do not follow the pizza shop on Facebook will not have an opportunity to participate.	The responses will be only from people who follow the pizza shop on Facebook.
c Although biased in the responses it will get, the survey will be useful in that it did get some publicity for the pizza restaurant.	261 people liked their post and 23 people shared it, so it was likely that it was just part of an advertising campaign.
d Advantages: Easy to conduct, willing participants, it is also advertising. Disadvantages: Biased as business is surveying only its own customers who are motivated to respond. Also, a person can vote multiple times.	



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Exercise 13B

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in the following statements.

- **a** A census is an official _____ of an *entire* population.
- **b** A survey is the process of gathering _____ from a small group, known as a _____, within a population.
- **c** The purpose of sampling is to gather _____ about the population. Information from the sample is used to estimate the _____ of the population, without the need to survey the entire population.
- **d** In a simple random sample, all members of a population have an _____ chance of being selected for the survey.
- **e** In a self-selected sample, anyone who _____ to participate answers the question(s) asked.

APPLICATIONS

SF: 2–3	CF: 4–6	CU: 7, 8

Example 2

★2 In the following situations for gathering information:

- **i** determine whether it is better to use a census or a sample
- **ii** explain the main reason for your choice.

- **a** the number of new homes built in a suburb
- **b** the popularity of the Prime Minister
- **c** the amount of people preferring to buy their groceries online
- **d** the amount of YouTube views for an artist

Hint It can be time consuming and expensive to survey the entire population.

★3 Determine whether a census or a survey has been conducted in the following scenarios.

- **a** To find the most popular type of new car on the road in Queensland, all registration details are checked for Queensland in the past year.
- **b** To find the most popular type of new car on the road in Queensland, 200 new car owners are asked what type of car they purchased.
- **c** To find the most popular fast food, 100 people in a shopping centre food court are asked what is their preferred fast food.
- **d** The batting average of a cricket player is calculated.

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Example 3 ★4 Mr Jones is the Sports Master at Alpha SHS. He wishes to survey the Year 11 group about their satisfaction with the variety of sports offered in the co-curricular program. He has decided to ask 10 students to participate in the survey. Below is a list of the Year 11 students, with boys' names written in blue and girls' names written in orange.

1 Ellie	11 Brenda	21 Bonnie	31 Jack	41 Thomas	51 Brent	61 Jennifer
2 Erica	12 James	22 Will	32 Rhys	42 Cassius	52 William	62 Jessica
3 Connor	13 Damian	23 Ned	33 Nicholas	43 Caleb	53 Dale	63 Oliver
4 James	14 Molly	24 Christopher	34 John	44 Matthew	54 Jake	64 Hamish
5 Mark	15 Steven	25 Liam	35 Michael	45 Jack	55 Caitlin	65 Henry
6 Thomas	16 Alexander	26 Courtney	36 Reid	46 Eamon	56 Charles	66 Katelyn
7 Tennelle	17 Chloe	27 Ryan	37 Alakiir	47 Meg	57 Lúc	67 Kobi
8 Samuel	18 Dominic	28 Charné	38 Angelo	48 Christopher	58 William	68 Jarrod
9 Amy	19 Thomas	29 Jacob	39 Jasper	49 Thomas	59 Clayton	69 Jack
10 Andrew	20 Kristen	30 Olivia	40 Breanna	50 Mark	60 Emma	70 Alexander

Mr Jones uses Excel to generate 10 random numbers. They are:
39, 57, 28, 15, 52, 58, 25, 10, 3, 5

a Identify the students that Mr Jones will ask to complete his survey.

b Of the Year 11 students:
- **i** Determine how many are boys.
- **ii** Calculate the fraction that are boys.

c Of the sample:
- **i** Determine how many are boys.
- **ii** Calculate the fraction that are boys.

d How suitable is Mr Jones' sample as a representation of the Year 11 students?

★5 Mr Jones repeats his survey from the previous question but uses a different selection of 10 random numbers. They are:
16, 10, 26, 54, 59, 14, 63, 68, 39, 32

a Identify the students that Mr Jones will ask to complete his survey.

b Of the Year 11 students:
- **i** Determine how many are boys.
- **ii** Calculate the fraction that are boys.

c Of the sample:
- **i** Determine how many are boys.
- **ii** Calculate the fraction that are boys.

d How suitable is Mr Jones' sample as a representation of the Year 11 students?

e Identify some advantages and disadvantages of Mr Jones' random sampling method for identifying the Year 11 students' satisfaction level with the sports offered.

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★6 Mr Jones is still not happy with his sample, so he decides to repeat his survey with a larger sample size of 20 students. He uses Excel to generate 20 random numbers between 1 and 70. They are:
52, 68, 4, 43, 3, 9, 57, 41, 45, 14, 42, 37, 21, 50, 27, 63, 13, 25, 26, 17

a Identify the students that Mr Jones will ask to complete his survey.

b Of the Year 11 students:

i Determine how many are boys.

ii Calculate the fraction that are boys.

c Of the sample:

i Determine how many are boys.

ii Calculate the fraction that are boys.

d How suitable is Mr Jones' sample as a representation of the Year 11 students?

Example 4 ★7 Voting in the KFC Classic Catches is an example of a self-selected survey. Participants in the competition are selecting their preferred catch; like they would select an option in a survey. Participants are placed into a draw to win a prize of $2000 and $50 worth of KFC.

a Who is likely to participate in this survey?

b What incentive is there to participate?

c In the survey's terms and conditions, it states that it costs 55 cents to vote and that people can enter the competition up to 90 times. What impact could this have on the outcome of the survey?

d Comment on the reliability of the survey method for determining the best Classic Catch of the summer.

e Identify some advantages and disadvantages of this self-selecting survey.

★8 Via an app on their devices, cricket fans can offer their opinion on what should happen during a game or who is the best player. There is no cost to participate. An example of a question polled through the app is shown at right.

a Identify the type of sampling technique used to collect this data.

b This question was polled at a time when Australia was closing in on winning the Ashes series against England 4–0 and Steve Smith had scored centuries in most of the innings. Consider the reliability of this data.

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13C Systematic sampling COMPLEX

LEARNING GOALS

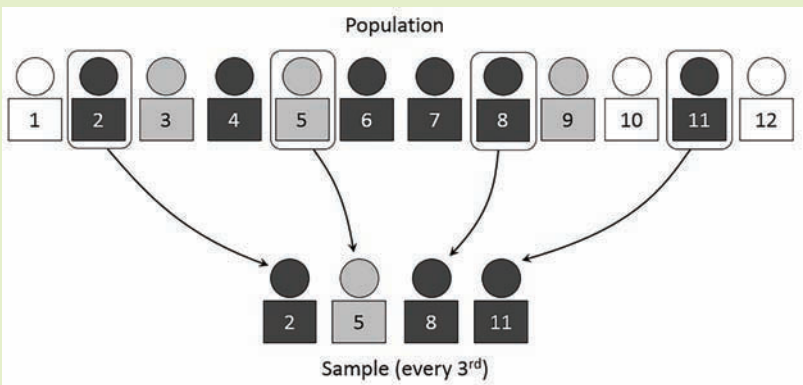
- Understand the procedure for selecting a systematic sample [Complex]
- Identify advantages and disadvantages of systematic sample techniques [Complex]

How are systematic samples essential?

Systematic samples are used in an attempt to overcome bias and imbalance that can come from using a random sampling technique to select a sample from a population.

WHAT YOU NEED TO KNOW

- A **systematic sample** is made by selecting subjects at regular intervals.
  - For example: Asking every third student in the tuckshop line what is their preferred menu option for lunch.



In a systematic sample, selections are made at regular intervals from a list.

- To determine how regularly a subject is selected from a list, we divide the population size by the required sample size.

$$\text{Interval} = \frac{\text{population size}}{\text{sample size}}$$

  - For example: If we wish to have a sample size of 15 from a population of 600 students, we would select every $\frac{600}{15} = 40$th student on the school roll.
- To avoid **bias**, generate a random starting place on the list to make the first selection.

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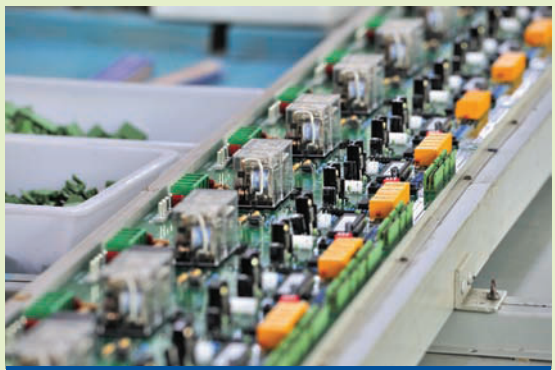
- Advantages: Very easy; the population is evenly sampled.
- Disadvantages: The sample can be biased in the following ways.
  - When the sample is not taken from a complete list of the population being investigated.
  - When some other trait of the population coincides with the frequency of selection or a trait occurs regularly in the population.
    - For example: If a faulty machine causes defects only in every 11th item manufactured, a sample taking every 10th item, out of a batch of 100, would include all good items and not be representative of the population.



Random samples are used to check the quality of production.

Example 5 Selecting a systematic sample

Mrs Dunsdon wants to use a systematic sample to select six students from her home room class to participate in a student satisfaction survey about the food at the tuckshop. The students in her class are:

1 Harrison	7 Sophie	13 Neve	19 Tom	25 Lily
2 Saxon	8 Angus	14 Lara	20 Arun	26 Tom
3 Dominic	9 Sam	15 Darcy	21 Oscar	27 Ryan
4 George	10 Laura	16 Ainsleigh	22 Theo	28 Libby
5 Stuart	11 Kiara	17 Eileen	23 Izak	29 Grace
6 Sapphire	12 Dougal	18 Douglas	24 Michelle	30 Kerri

a Determine how regularly a student will need to be selected.

b Use a random number generator to select a random starting point on the list.

c Select the sample of students to be used in the survey.

d Determine if the sample has the same mix of boys and girls as the home room class.

e Consider whether this method is suitable in selecting a sample that represents the population.

f Identify some advantages and disadvantages of Mrs Dunsdon's systematic sampling method for discovering this school's student satisfaction level of tuckshop food.

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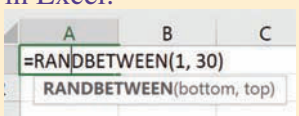
WORKING	THINKING
a Interval $= \frac{30}{6} = 5$ So choose every fifth student.	Interval $= \frac{\text{population size}}{\text{sample size}}$
b Using Excel, start = 11.	Enter this formula in a cell in Excel: 
c The students to select will be:	Select student 11 and then select every fifth student from the list after the 11th student. When you reach the end of the list, go back to the start.

1 Harrison	7 Sophie	13 Neve	19 Tom	25 Lily
2 Saxon	8 Angus	14 Lara	20 Arun	26 Tom
3 Dominic	9 Sam	15 Darcy	21 Oscar	27 Ryan
4 George	10 Laura	16 Ainsleigh	22 Theo	28 Libby
5 Stuart	11 Kiara	17 Eileen	23 Izak	29 Grace
6 Sapphire	12 Dougal	18 Douglas	24 Michelle	30 Kerri

Kiara, Ainsleigh, Oscar, Tom and Harrison.

d Fraction (class) girls $= \frac{13}{30}$ or 0.43 Fraction (sample) girls $= \frac{3}{6}$ or 0.5 The sample and class proportions of girls is very close, so the sample is suitable.	When dealing with small samples, we might not always get exactly the same proportion.
e The sample reflects the same characteristics as the population, therefore this has been a suitable method for determining the sample.	Give a reason for your decision.
f Advantages: It is easy and the class has been evenly sampled. Disadvantages: It is a very small sample and might include students who don't use the tuckshop. Also, the results represent only Year 11 attitudes, not those of the whole student population.	The sample must be taken from a complete list of the population being investigated, otherwise the sample will be biased.

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Exercise 13C

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in the following statements.

- **a** A systematic sample is made by selecting subjects from a list at _____ intervals.
- **b** To determine how regularly a subject is selected from a list, _____ the population size by the required sample size.
- **c** To avoid bias, start at a _____ place on the list to make the first selection.

Example 5a

2 For the following population sizes, determine the interval required between selections for the stated sample size.

- **a** population = 750, sample size = 25
- **b** population = 225, sample size = 15
- **c** population = 480, sample size = 30
- **d** population = 65, sample size = 20
- **e** population = 1356, sample size = 75

Hint: Interval = $\frac{\text{population size}}{\text{sample size}}$

APPLICATIONS

SF: – | CF: 3–5 | CU: –

★3 Describe the advantages and disadvantages of a systematic random sample.

★4 Identify how bias has been introduced in the following systematic sampling procedures.

- **a** Systematically selecting names from the electoral roll to determine Australian adults' attitudes to home ownership.
- **b** Systematically selecting names from an alphabetical list of Years 11 and 12 students to determine Australian teenage attitudes to drug taking.

Hint: The sample must be taken from a *complete* list of the population being investigated.

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Example 5

5 Mr Jones is the Sports Master at Alpha SHS. He wants to survey the Year 11 students about their satisfaction with the variety of sports offered in the co-curricular program. He has decided to ask a sample size of 10 students to participate in the survey.

1 Ellie	11 Brenda	21 Bonnie	31 Jack	41 Thomas	51 Brent	61 Jennifer
2 Erica	12 James	22 Will	32 Rhys	42 Cassius	52 William	62 Jessica
3 Connor	13 Damian	23 Ned	33 Nicholas	43 Caleb	53 Dale	63 Oliver
4 James	14 Molly	24 Christopher	34 John	44 Matthew	54 Jake	64 Hamish
5 Mark	15 Steven	25 Liam	35 Michael	45 Jack	55 Caitlin	65 Henry
6 Thomas	16 Alexander	26 Courtney	36 Reid	46 Eamon	56 Charles	66 Katelyn
7 Tennelle	17 Chloe	27 Ryan	37 Alakiir	47 Meg	57 Lúc	67 Kobi
8 Samuel	18 Dominic	28 Charné	38 Angelo	48 Christopher	58 William	68 Jarrod
9 Amy	19 Thomas	29 Jacob	39 Jasper	49 Thomas	59 Clayton	69 Jack
10 Andrew	20 Kristen	30 Olivia	40 Breanna	50 Mark	60 Emma	70 Alexander

Use this list of students to answer the following questions. The boys' names are shown in blue font and the girls' names are in orange font.

a Determine how regularly a student will need to be selected from the list.

b Starting at 50, select the sample of students to be used in the survey.

Hint When you reach the end of the list, go back to the start.

c Determine if the sample has the same mix of boys and girls as the Year 11 group.

d Explain whether this method has been suitable in selecting a sample that represents the population.

e Mr Jones is not happy with his sample.

- **i** Starting at 27, select the sample of 10 students to be used in the survey.
- **ii** Determine if the sample has the same mix of boys and girls as the Year 11 group.
- **iii** Explain whether this method has been suitable in selecting a sample that represents the population.

f The size of the sample can also affect the reliability of the sample that is selected. Mr Jones thinks that he might get a more reliable sample if he increases the sample size to 20.

- **i** Determine how regularly a student will need to be selected from the list.
- **ii** Starting at 50, select the sample of 20 students to be used in the survey.
- **iii** Determine if the sample has the same mix of boys and girls as the Year 11 group.
- **iv** Explain whether this method has been suitable in selecting a sample that represents the population.

g Comment on the reliability of a systematic sample as a method for selecting a sample.

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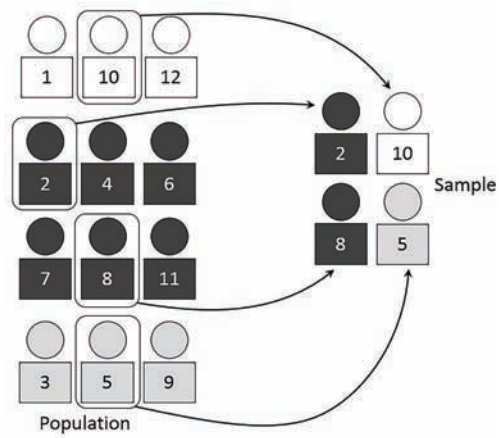
13D Stratified sampling

LEARNING GOALS

- Understand the procedure for selecting a stratified sample
- Identify advantages and disadvantages of stratified samples

Why is stratified sampling essential?

As we have seen in the previous sections, random sampling can result in the characteristics of the sample not being the same as the characteristics of the population they are taken from. For example, if a higher or lower percentage of women are in the sample than in the population, this can lead to bias in the results obtained from a survey. A stratified sample tries to overcome any sampling imbalances by first dividing the population into groups, taking a random sample from each group and merging these to make one sample.



A stratified sample combines separate random samples from each subgroup of a population.

WHAT YOU NEED TO KNOW

- A **stratified sample** has the same characteristics as the population it is drawn from.
- To achieve the same characteristics and proportions in the sample, the population is divided up into groups that are called **strata**. The proportions of these groups are calculated, generally as a fraction or a percentage, and applied to the sample. Some examples of population characteristics that can be applied to the sample are:
  - geographic location
  - age
  - year level at school
  - ethnic background
- Once it is determined how many people should be surveyed from each strata group, a *random* sample is taken from each group to form the sample.
- The main *advantage* of a stratified sample is that it has the same characteristics of the population.
- The main *disadvantage* of a stratified sample is that it can be more time consuming to determine the sample.

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Example 6 Selecting a stratified sample, keeping member proportions the same

Morgan is the president of the local hockey club. The club has 480 members of which 280 are juniors, 150 are seniors and the remainder are life members. Morgan wishes to survey 10% of the members about changes to the club uniform.

a Calculate how many members she will survey.
b Calculate how many senior members should be included in the survey.
c Calculate how many juniors should be included in the survey.
d Calculate how many life members should be included in the survey.
e Verify that your stratified sample is appropriate.

WORKING	THINKING
a Sample size $= \frac{10}{100} \times 480$ $= 48$	Calculate 10% of the total membership. On your calculator enter: $10 \div 100 \times 480 =$
b Seniors $= \frac{150}{480} \times 48$ $= 15$	Seniors make up $\frac{150}{480}$ of the total membership, so they need to make up the same fraction of the sample.
c Juniors $= \frac{280}{480} \times 48$ $= 28$	Juniors make up $\frac{280}{480}$ of the total membership, so they need to make up the same fraction of the sample.
d Life members $= 480 - 280 - 150$ $= 50$ Life members $= \frac{50}{480} \times 48$ $= 5$	First calculate how many life members there are. Life members make up $\frac{50}{480}$ of the total membership. So they need to make up the same fraction of the sample.
e Sample $= 15 + 28 + 5$ $= 48$ This is the sample size calculated in part **a**.	Check the final sample is 10% of the members.

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Example 7 Selecting a stratified sample, keeping the same proportions of boys and girls as those in the class

Mrs Dunsdon wants to select 20% of students from her home room class to participate in a student satisfaction survey about the food at the tuckshop. Her class list shows boys' names written in blue and girls' names written in orange. She wants to use a stratified sample to ensure her sample has the sample proportions of girls/boys as those of her class.

Harrison	Sapphire	Kiara	Ainsleigh	Oscar
Saxon	Sophie	Dougal	Eileen	Theo
Dominic	Angus	Neve	Douglas	Izak
George	Sam	Lara	Tom	Michelle
Stuart	Laura	Darcy	Arun	Lily

a Calculate how many students are in the class.
b Calculate how many students in the class are boys.
c Calculate how many students in the class are girls.
d Calculate how many students will be included in the survey.
e Calculate how many students in the sample will be boys.
f Calculate how many students in the sample will be girls.
g Use Excel to generate random numbers to determine which boys will be used in the sample.
h Use Excel to generate random numbers to determine which girls will be used in the sample.

WORKING	THINKING
a There are 25 students in the class.	This is the population.
b 15 students are boys.	This is the size of one of the strata groups.
c 10 students are girls.	This is the size of the other strata group.
d Sample size $= \frac{20}{100} \times 25 = 5$	Calculate 20% of the class.
e Boys $= \frac{15}{25} \times 5 = 3$	The sample must have three boys to have the same proportion of boys as the class.

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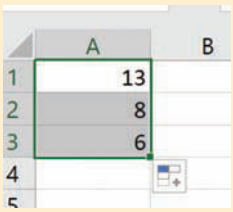
WORKING

f Girls $= \frac{10}{25} \times 5 = 2$

The sample must have two girls to have the same proportion of girls as the class.

g Boys' sample:

There are 15 boys. Type =RANDBETWEEN(1, 15) into Excel and fill down to calculate three random numbers.



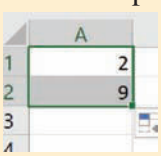
Select the 13th, 8th and 6th boys from the class list.

1 Harrison	1 Sapphire	4 Kiara	7 Ainsleigh	13 Oscar
2 Saxon	2 Sophie	8 Dougal	8 Eileen	14 Theo
3 Dominic	6 Angus	5 Neve	10 Douglas	15 Izak
4 George	7 Sam	6 Lara	11 Tom	9 Michelle
5 Stuart	3 Laura	9 Darcy	12 Arun	10 Lily

Angus, Dougal and Oscar will make up the boys' sample.

h Girls' sample:

There are 10 girls. Type =RANDBETWEEN(1, 10) into Excel and fill down to calculate two random numbers.



Select the 9th and 2nd girls on the class list.

1 Harrison	1 Sapphire	4 Kiara	7 Ainsleigh	13 Oscar
2 Saxon	2 Sophie	8 Dougal	8 Eileen	14 Theo
3 Dominic	6 Angus	5 Neve	10 Douglas	15 Izak
4 George	7 Sam	6 Lara	11 Tom	9 Michelle
5 Stuart	3 Laura	9 Darcy	12 Arun	10 Lily

Sophie and Michelle will make up the girls' sample.

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Exercise 13D

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in the following statements.

a A stratified sample has the same _____ as the population it is drawn from.

b To achieve the same characteristics and _____ in the sample, the population is divided up into _____ that are called strata.

c The proportions of the strata groups are calculated, generally as a _____ or a _____, and applied to the sample.

Example 6a

2 Evaluate the following.

a $\frac{15}{90} \times 54$

b $\frac{120}{350} \times 70$

c $\frac{37}{62} \times 5$

d $\frac{120}{320} \times 40$

APPLICATIONS

SF: – | CF: 3–5 | CU: 6, 7

★3 List the advantages and disadvantages of a stratified random sample.

Example 6

★4 A local supermarket has 145 employees of which 50 work full-time, 35 work part-time and the rest are casual employees. The manager wishes to survey 20% of the staff about job satisfaction.

a Calculate how many casual employees there are.

b Calculate how many employees will be included in the survey.

c To get a true reflection of the staff in the sample, the manager would like to use a stratified sample. Calculate how many of each of the following she should include.

i full-time employees

ii part-time employees

iii casual employees

Hint First calculate the population fractions for each type of employee.

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A good sample has the same proportion of subgroups as in the population.

Example 7 ★5 The Year 11 Coordinator would like to survey 15% of Year 11 students about the school formal next year. The Year 11 students are made up of 40 girls and 52 boys, and the Coordinator wishes to use a random stratified sampling technique.
He has made up a list of all the students in Year 11.

Girls:

1 Gabrielle	6 Breanna	11 Mia	16 Claire	21 Julia	26 Chloe	31 Emily	36 Meg
2 Amy	7 Caitlin	12 Gabriella	17 Caitlin	22 Ellie	27 Kristen	32 Gabrielle	37 Cassie
3 Molly	8 Emma	13 Claudine	18 Katelyn	23 Erica	28 Meg	33 Tara	38 Shania
4 Bonnie	9 Jessica	14 Isabella	19 Caitlyn	24 Tenielle	29 Jennifer	34 Heidi	39 Nikita
5 Courtney	10 Ruby	15 Keely	20 Kate	25 Brenda	30 Bonnie	35 Georgia	40 Codey

Boys:

1 Christopher	8 William	15 Christopher	22 Jake	29 Riley	36 James	43 Will	50 Jasper
2 Thomas	9 Seamus	16 Liam	23 Charles	30 Thomas	37 Samuel	44 Ned	51 Caleb
3 Andrew	10 Thomas	17 Ryan	24 Oliver	31 Matthew	38 Damian	45 Jack	52 Jack
4 Jacob	11 Sean	18 Matthew	25 Henry	32 Elliot	39 Steven	46 Rhys	
5 John	12 Braden	19 Thomas	26 Jack	33 Matthew	40 Alexander	47 Nicholas	
6 Alexander	13 Mark	20 Brent	27 Jack	34 Thomas	41 Dominic	48 Michael	
7 Benjamin	14 James	21 William	28 Matthew	35 Connor	42 Thomas	49 Angelo	

a Calculate how many students will be required for the survey.
b Calculate how many students in the survey will be girls.
c Calculate how many students in the survey will be boys.
d Use this list of random numbers between 1 and 40 to select the sample of girls:
20, 26, 39, 25, 16, 18, 40
12, 21, 30, 6, 23, 1, 10

Hint Note: Work your way across the first row until you have the sample size required.

e Use this list of random numbers between 1 and 52 to select the sample of boys:
25, 26, 14, 43, 35, 32, 10, 8, 23 6, 14, 30, 6, 39, 22

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★6 Geometry College is a co-educational boarding school. The Year 11 students comprise the following distribution.

	Day student	Boarder	Total
Girl	55	23	78
Boy	65	37	102
Total	120	60	180

The School Board would like to conduct a stratified survey of 20% of the Year 11 students to find their opinion about homework expectations.

a Calculate how many students will need to be surveyed.

b Calculate how many of each of the following students will be selected.

- **i** girl day students
- **ii** girl boarders
- **iii** boy day students
- **iv** boy boarders

★7 According to the Australian Bureau of Statistics, the Population of Australia in June 2017 was as shown in the table.

Population at end of June quarter 2017

Preliminary data	'000
New South Wales	7861.1
Victoria	6323.6
Queensland	4928.5
South Australia	1723.5
Western Australia	2580.4
Tasmania	520.9
Northern Territory	246.1
Australian Capital Territory	410.3
Australia	**24598.9**

a There are 76 Senators in the Australian Senate, each representing the various States and Territories of Australia. If States and Territories are allocated numbers of seats in the Senate according to the principles of a stratified sample, calculate how many seats in the Senate each State or Territory should have?

b The Senate is made up of 12 senators from each State and two each from the Australian Capital Territory and the Northern Territory. Compare this with your answers from part **a** and comment on the allocation of seats in the Australian Senate.

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13E Identifying target populations

LEARNING GOALS

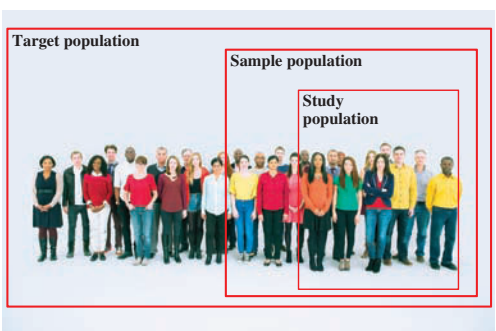
- Identify target populations for a survey
- Describe target, sample and study populations
- Understand the importance of the identification of a target population

Why is identification of a target population essential?

When designing a survey, you need to be aware of your target population. When you use a survey to gather information about a population, it is important that your survey participants are from a group within the overall population that you are trying to make generalisations about. Suppose you wished to find the average number of hours a learner driver spends with a driving school during their driver training; it would make sense to survey P-plate drivers about their experiences. It would not make sense to ask a group of Year 8 students about their driver training!

WHAT YOU NEED TO KNOW

- **Target population** refers to the *entire* group of individuals you are interested in for your survey.
  - For example: all P-plate drivers in Queensland.
- **Sample population** is the group of individuals asked to participate in your survey.
  - For example: 10% of the P-platers at all the high schools in your suburb/town.
- **Study population** is the final group of people who agree to be involved in your survey. Being a smaller group, the data collected from the study group is easier to collect and manage. A survey can give accurate information about the target population only when information is taken in an unbiased way from the target population.



Target, sample and study populations

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Example 8 Identifying the target population for a customer survey

A chemist shop wishes to know if customers are happy with its service. The business emails customers who use its store loyalty card when making a purchase on a Saturday morning. Determine which one of the following is the target population:

A all the customers of the chemist shop
B the customers surveyed
C all the staff working in the chemist shop
D all the customers of all the shops in the shopping centre

WORKING	THINKING
Option A; all the customers of the chemist shop	Consider which population the customers belong to.

Example 9 Identifying the target population and why this is important

A local council wishes to know the opinions of residents of a suburb about the construction of a water detention basin, for storm water runoff, in a local park. It surveys 50 residents from the suburb.

a Determine which one of the following is the target population:
  A the 50 residents surveyed
  B the council workers
  C all the residents of the suburb
  D all the residents of the city

b Explain why it is important to identify this target population.

WORKING	THINKING
a option C	Consider which population the sample is a part of.
b If survey participants are not suburb residents, you cannot make generalisations about the residents' views.	To make generalisations about a population, the survey participants must be only from that population.

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Example 10 Describing the target population and why this is important

Tourism Queensland surveys people about their satisfaction with the Kuranda scenic railway trip, which departs from Cairns.

a Describe the target population.

b Explain why it is important to identify this target population.

WORKING	THINKING
a People who have used the Kuranda scenic railway.	The target population includes people using this scenic railway, not just tourists to the Cairns area.
b Conclusions would not be accurate if survey participants had not experienced the Kuranda scenic railway.	To make generalisations about a population, the survey participants must be only from that population.

To investigate hours of driving school training, the target population comprises all P-plate drivers.

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Exercise 13E

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in the following statements.

- **a** Target population refers to the _____ group of individuals you are interested in for your survey.
- **b** _____ population is the group of individuals asked to participate in your survey.
- **c** Study population is the final group of people who _____ to be involved in your survey.
- **d** A survey can give _____ information about the target population only when information is taken in an unbiased way from the target population.

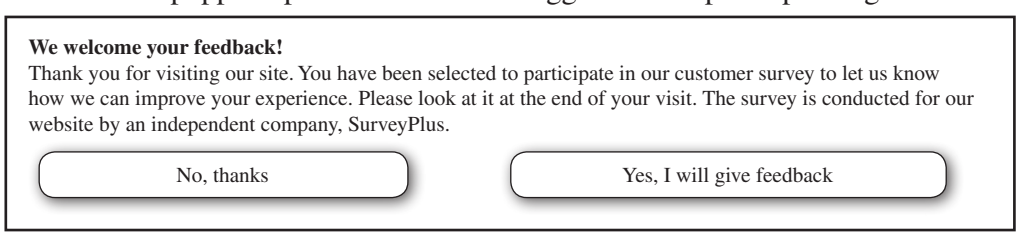
2 Match each sample (**A** to **D**) with its corresponding target population (**i** to **iv**).

Sample	Target population
A lettuce plants in a row	**i** all P-plate drivers in Queensland
B P-plate drivers in Year 12	**ii** all the customers of a business
C parents at a P & F meeting	**iii** all the parents of the school
D customers who respond to an email survey	**iv** all the lettuce plants on the farm

APPLICATIONS

SF: 3–11 | CF: – | CU: –

Example 8 ★**3** This window popped up when a customer logged on to a photo printing website.


We welcome your feedback!
Thank you for visiting our site. You have been selected to participate in our customer survey to let us know how we can improve your experience. Please look at it at the end of your visit. The survey is conducted for our website by an independent company, SurveyPlus.
No, thanks
Yes, I will give feedback

The target population is:

- **A** all people who use online providers to print photos
- **B** all the members who use this website to print photos
- **C** professional photographers who print photos
- **D** all people who take photos

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★4 Shortly after doing the grocery shopping at a supermarket and using her customer loyalty card, Leanne received this message in an email from the supermarket.

> **Tell Gold supermarkets about it and get 100 bonus loyalty points!**
>
> Help us make your shopping experience even better by completing our survey. Click on the link below and tell us about your recent visit to our supermarket. To say thanks, we will give you 100 bonus loyalty points.
>
> **Start survey**

The target population is:

A all people who shop at the supermarket
B all people who shopped at the supermarket that day
C all people who shopped in the shopping centre that day
D employees of the supermarket

Example 9 ★5 A school wishes to know the students' preference for home room classes.

a What is the target population?

A students from Year 11 only
B students who are new to the school
C students who have older brothers and sisters
D all students of the school

Hint To make generalisations about a population, the participants must be only from that population.

b Explain why it is important to identify this target population.

★6 A business wishes to know if providing free access to a local gym during an employee's lunch break would be considered beneficial by the employees.

a What is the target population?

A employees who wish to be fitter
B employees who are overweight
C all employees of the company
D employees who do not move much during the workday

b Explain why it is important to identify this target population.

Example 10 ★7 Tourism Queensland wishes to know the satisfaction levels of people taking boat trips to see the Great Barrier Reef.

a Describe the target population.
b Explain why it is important to identify this target population.

★8 A vegetable grower wishes to check his plants for pests. He checks (i.e. surveys) a row of plants to see if he can find any. Describe the target population.

★9 For quality assurance, a factory worker checks random items as they leave the production line. Describe the target population.

★10 A local factory surveys its employees about the benefits of providing onsite childcare for the employees' children. Describe the target population.

★11 A political party uses a consultation group to survey voters via a phone poll on their preferred Prime Minister. Describe the target population.

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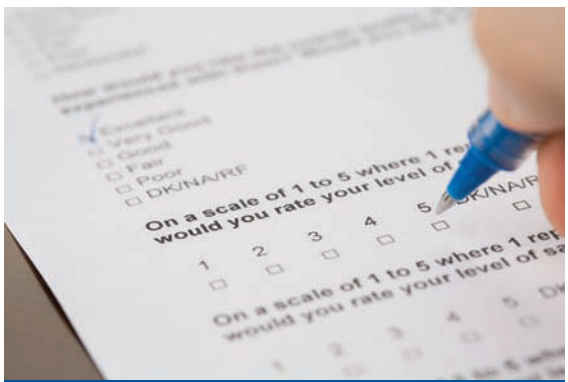
13F Questionnaire design principles

LEARNING GOALS

- Investigate and understand questionnaire design principles, including:
  - simple language
  - unambiguous questions
  - consideration of the number of response choices
  - issues of privacy and ethics
  - freedom from bias.

When are questionnaire design principles essential?

It is important to ask survey questions without ambiguity and bias. The questions must also be easy for the participant to understand and designed to allow you to be able to process the data effectively.



The available responses should accommodate all possible responses within a few choices.

WHAT YOU NEED TO KNOW

When designing a questionnaire, you need to consider the following principles.

- **Use simple language:** Do not use jargon or technical words in the survey questions that respondents may not understand. Be brief and keep sentences to fewer than 20 words.
- **Do not make questions ambiguous:** The meaning of your question must be very clear. Avoid words like rarely, sometimes, usually, few, some and most.
- **Consideration of the number of response choices:** Asking lots of questions or having lots of options to choose from when answering a question can lead to survey fatigue in the sample group. People are more likely to remember the first and the last choice when offered a lot of options.
- **Issues of privacy and ethics:** The information collected during a survey must be kept confidential and not shared with unauthorised people.
- **Freedom from bias:** Questions should not be leading the respondent to a particular answer.

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Example 11 Designing responses with suitable choices

A local gym wishes to survey its clients about the amount of time per week they spend at the gym. The survey question is: How much time do you spend at this gym each week?

Here are two possible survey response options.

Option A: ☐ 2 hours ☐ 4 hours

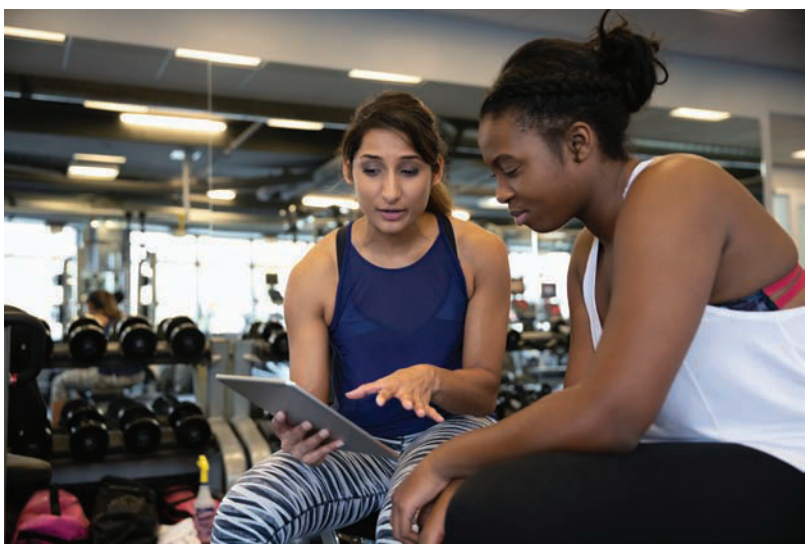
Option B: ☐ 1 hour ☐ 2 hours ☐ 4 hours ☐ 5 hours ☐ 8 hours ☐ 15 hours

a For option A, identify one issue and describe why it is a problem.

b For option B, identify one issue and describe why it is a problem.

c Rewrite the answer options to cover a wide variety of hours with only four options to choose from.

WORKING	THINKING
a Option A has too few possible answers, so the survey conclusion will not be accurate.	Consider what is the smallest and largest number of hours that a person could exercise at the gym.
b Option B has too many possible answers, making it hard to collate the results.	It would be very time consuming to collate results from every possible answer.
c ☐ 1–2 hours ☐ 3–4 hours ☐ 5–6 hours ☐ more than 6 hours	The available responses should accommodate all possible responses within a few choices.



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Example 12 Simplifying the language of questions

Rewrite each of the following questions in a simpler form.

a Which teacher is the most knowledgeable and friendly?

b With what frequency has your child experienced a raised temperature in the past 30 days?

c Including yourself, any pets you own, but not including any relatives or friends that do not live in your household for at least 320 days a year, how many household occupants did you buy groceries, by groceries we mean any item of food bought at the grocery store, for in the last year?

WORKING	THINKING
a Which teacher is the most knowledgeable? Which teacher is the friendliest?	A double-barrelled question makes it difficult to answer both parts accurately. The most knowledgeable teacher may not also be the friendliest.
b How many times has your child had a fever in the past month?	Use simple words and keep sentences as short as possible.
c Including yourself, and any pets, how many regular household occupants did you buy groceries for in the past year?	Keep sentences short and under 20 words. There is too much information in the original question.

Example 13 Wording questions to remove any ambiguities

Identify any ambiguous words in these questions and rewrite without any ambiguity.

a Do you usually purchase plane tickets online?

b Do you drink?

WORKING	THINKING
a Rewrite as: How often do you purchase plane tickets online?	It is unclear how often is 'usually'. It is better to get an exact response from the respondent.
b Rewrite as: Do you drink sports drinks?	It is unclear what type of drink you are referring to: water, soft drinks, caffeine drinks…?

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Example 14 Designing questions free of bias

Identify any bias in the following questions and rewrite the question.

a Most of our clients prefer the look and feel of our renovated gym over the old one. How do you feel?

b The cost of concert tickets continues to go up to cover rising security costs. Do you think you should have to pay more when you buy your ticket or should the promotors be absorbing the rising costs?

WORKING	THINKING
a Rewrite as: How do you feel about the renovations to the gym?	The original question is leading the respondent to agree with 'most of the clients'.
b Rewrite as: How much are you willing to pay for a concert ticket to cover additional security?	The original question is loaded and is providing a reason for a problem.

Exercise 13F

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in the following statements.

a When writing a survey question, it is important to not use jargon or _____ words that respondents may not understand. Be brief and keep sentences to fewer than ____ words.

b Questions should not be ambiguous. The _____ of your question must be very _____. Avoid words like rarely, sometimes, usually, few, some and most.

c Consideration needs to be given to the _____ of response choices. Asking lots of questions or having lots of options to choose from when answering a question can lead to survey _____ in the sample group. People are more likely to remember the first and the last choice when offered a lot of options.

d Issues of _____ and ethics need to be considered when conducting a survey. The information collected during a survey must be kept confidential and not _____ with unauthorised people.

e Questions must be free from _____ and should not be _____ the respondent to a particular answer.

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Example 11

2 The manager at a council swimming pool wishes to survey the people who use the pool about the amount of time they spend swimming per week.
The survey question is: How much time do you spend swimming at this swimming pool each week?
Here are two possible survey response options to include after this question.
Option A: ☐ 1 hour ☐ 5 hours
Option B: ☐ 1 hour ☐ 2 hours ☐ 3 hours ☐ 4 hours ☐ 5 hours
☐ 6 hours ☐ 7 hours

a Identify one issue in option A and describe why it is a problem.
b Identify one issue in option B and describe why it is a problem.
c Rewrite the answer options to cover a wide variety of possible hours with only four options to choose from.

Hint The available responses should accommodate all possible responses within a few choices.

APPLICATIONS

SF: – | CF: 3–8 | CU: 9

Example 12

★3 Consider the survey question: Does it seem possible or impossible that NSW will win the State of Origin, or do you feel they will always find a way to lose?

a Is this question too long?
b Besides bias, determine the key problem with this question.
c Identify the way in which this question contains bias.
d Rewrite the question so it is easier to respond to.

★4 Consider the survey question: Students must take standardised NAPLAN tests in reading, writing and mathematics. Some teachers feel that students take too many tests. Others feel more should be required to test students in science and social studies. Do you think that your students take too many standardised tests?

a This question contains jargon commonly used by teachers when speaking with other teachers. Identify word(s) that could be considered jargon.
b The question is also rather long. Consider whether any of the question can be cut out.
c Rewrite the question so it is easier to understand.

Example 13

★5 Consider the question: Where do you like to shop?

a Explain what makes this question ambiguous.
b Rewrite the question to find out where people like to do their grocery shopping.
c Rewrite the question to find out where people like to shop online.
d Rewrite the question to find out where people like to buy their runners from.

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★6 Consider the question: Where did you come from?

a Explain what makes this question ambiguous.

b Rewrite the question to find out where the person was born.

c Rewrite the question to find out where the person spent the morning.

Example 14 ★7 Identify which of the following questions do *not* contain any bias.

a Do you feel the TV news shows only the negative side of life?

b Do you prefer the look of the plush new lounge?

c Do you think school BYO computer policies advantage the wealthy?

d Do you prefer this delicious flavoured milkshake or plain vanilla?

★8 Identify any bias in these questions and rewrite without bias.

a Do you think the government should spend more money on the military to avoid a catastrophic invasion of the country?

b Do you think the new policy is good?

c Do you think the new recipe is better than the old recipe?

d Do you think students should be allowed access to their own mobile phones while at school?

e Government employees love their jobs. How do you feel about your job with the government?

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★**9** Jenny has designed a questionnaire to survey students about the sports offered at school. Read her draft questionnaire and answer the questions that follow.

Question 1 How many times do you participate in sport and physical activity in a week?

☐ 1–2 ☐ 3–4 ☐ 5–6

Question 2 Please state what sport(s) you do at school. _____

Question 3 If you would like to do activities at school, when would you like to do them?

_____

Question 4 Do you think the limited options of sports available at school are reasonable?

Question 5 People believe the school should offer more sports. If you agree, what sports should they offer?

Question 6 Personal details: Year group _____ Name: _____
Gender _____ Date of birth: _____

Please place your completed survey in the box outside the Sports Staffroom.

a Question 1: This is a closed question because options are offered for the answer.
- **i** Is it clear where the sport and physical activity occurs? Remember that Jenny is surveying students about the sports offered at school.
- **ii** Rewrite the question to remove any ambiguity.
- **iii** If a student does no sport, consider how they can answer.
- **iv** If a student does sport and exercise every day, what answer can they select?
- **v** Correct the available responses to accommodate all possible responses.

b Question 2: Is an example of an open-ended question, as a space is available to write a response. Jenny will get a range of answers to this question. It will be easier to process the data if options are available for the respondents to tick their response. Suggest a series of sports with tick boxes that Jenny could use.

c Question 3: A range of responses would be expected. Suggest a series of times, with tick boxes, that Jenny could use.

d Question 4 is an open-ended question.
- **i** Identify the way in which the question is biased.
- **ii** Rewrite the question to remove any bias.

e Question 5 is an open-ended question.
- **i** Identify the problem with this question.
- **ii** Rewrite the question to remove any issues with it.

f Question 6 collects personal information from respondents.
- **i** Is the information collected necessary for the survey?
- **ii** Do you predict any issues with the way the survey responses are to be collected?

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Problem-solving and modelling task

IS SOCIAL MEDIA DIVIDING US OR CONNECTING US?

Background: Social media is making us more connected than any time in history… or is it? Do we chat more online than face-to-face? Are we becoming addicted to our smart phones? Is it easier to 'like' a post than compliment someone when we see them face-to-face?

Task: You are to design, run and report on a survey of social media use amongst your peers. Specifically, find out what apps are popular, how much time your peers spend on social media, how connected they are with 'friends', and how they communicate with friends.

To complete this task, follow the problem-solving workflow diagram on the following page and use the steps listed as a guide.

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Stage 1: Formulate

1. What information do you have?
2. What information do you need to find out?
3. How will you conduct the survey?
4. How many people will you survey?
5. How will you determine who will be in your survey?

Stage 2: Solve

6. Write your questions.
7. Conduct your survey.
8. Collate your results.
9. Present the information in a graph or table.

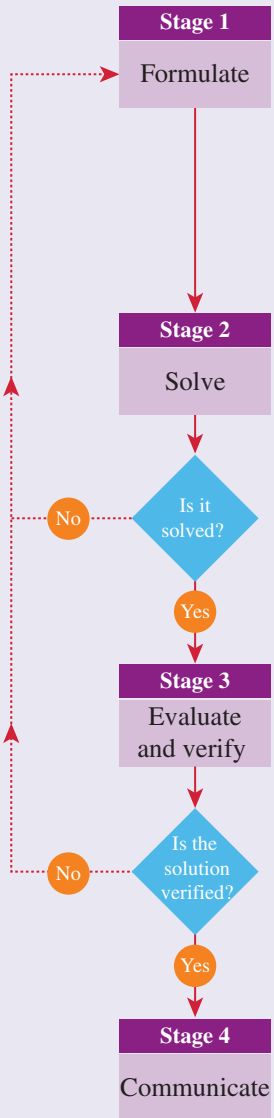
Stage 3: Evaluate and verify

10. Are your questions written without bias and ambiguity?
11. Did you get the responses you expected?

Stage 4: Communicate

Write a report with an introduction, body and conclusion.

12. State your main point.
13. Include the evidence in the form of statements, graphs and tables.
14. Explain the evidence. Use a sentence starter like 'This means…'.
15. In the conclusion, link back to your main point.



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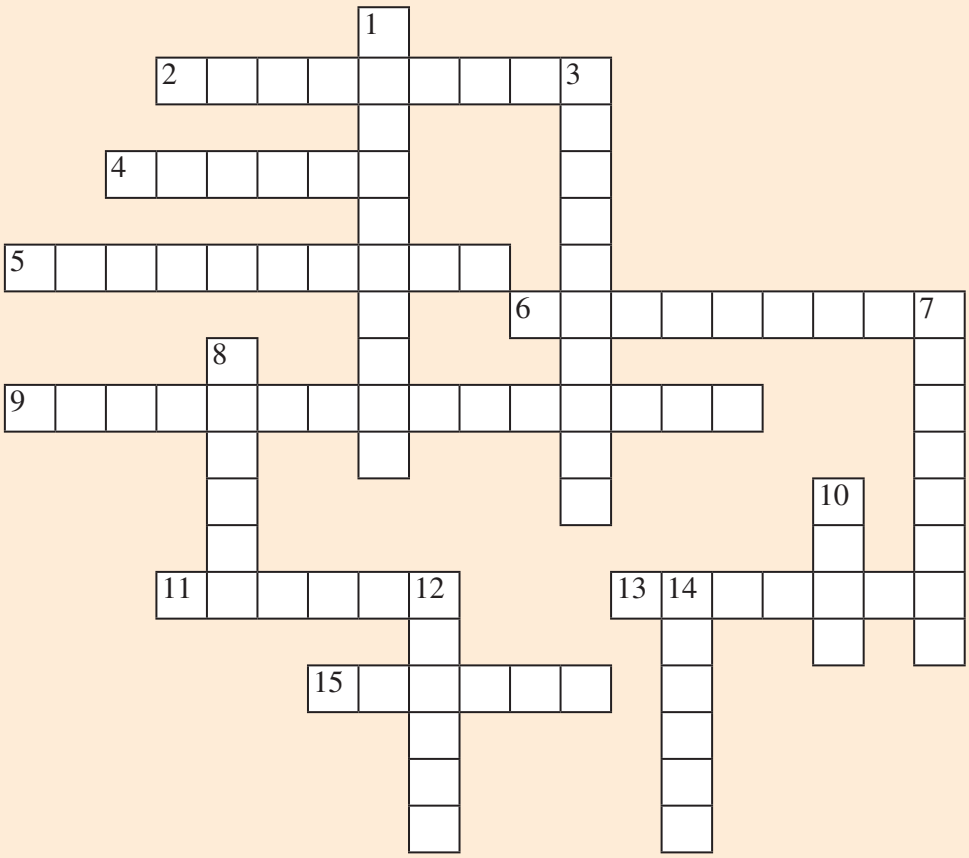
Puzzle



Across

2 A questionnaire is a group of _____.
4 Groups used in stratified sampling
5 A study ____ is the group of people involved in a survey.
6 A question that is unclear is ____.
9 A sample should have the same ____ as the population.
11 A count of an *entire* population
13 Information collected must be kept ____.
15 The ____ population is the group you wish to learn about.

Down

1 _____ sampling produces a sample with the same proportions as the population.
3 ____ sampling selects participants at regular intervals from a list.
7 Self- ____ means survey participants volunteer.
8 A group of individuals asked to participate in a survey
10 A question asked with influence is said to have ___.
12 The process of gathering information from a sample group
14 The sample is selected by chance

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Chapter checklist

☐ I understand the procedures for conducting a census.

1 a What is a census?
b How is a census conducted?

☐ I understand the advantages and disadvantages of a census [Complex].

2 a Explain three advantages of a census.
b Explain three disadvantages of a census.

☐ I know the difference between a census and a survey.

3 a What is a survey?
b Explain the advantages of a survey.
c Explain the disadvantages of a survey.

☐ I understand the purpose of sampling.

4 Explain the purpose of sampling.

☐ I know about simple random samples [Complex].

5 a Describe how to select your sample using this technique.
b Explain the advantages of a simple random sample.
c Explain the disadvantages of a simple random sample.

☐ I know about self-selected samples [Complex].

6 a Describe how a self-selected sample works.
b Explain the advantages of a self-selected sample.
c Explain the disadvantages of a self-selected sample.

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☐ I know about systematic samples [Complex].

7 a Describe how a systematic sample works.
b Explain the advantages of a systematic sample.
c Explain the disadvantages of a systematic sample.
d Write down the missing word in the following sentence.
If we wish to systematically select 20 students from a school of 500 to participate in a survey, we select every _____th student on the roll.

☐ I know about stratified random samples [Complex].

8 a Describe how a stratified random sample works.
b Explain the advantages of a stratified random sample.
c Explain the disadvantages of a stratified random sample.

☐ I can identify a target population.

9 a Describe the target population.
b Describe the sample population.
c Describe the study population.

☐ I understand the principles of designing a questionnaire [Complex].

10 a Explain what it means to use simple language.
b Describe what is meant by ambiguous questions.
c Explain why we need to consider the number of response choices.
d Of any data obtained, explain why we need to consider privacy and ethics.
e Explain what is meant by the term bias.

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Chapter review

All questions in the Chapter Review are assessment-style.

Simple Familiar

1 Match each term (**A** to **I**) with its definition (**i** to **ix**).

A	census	**i**	The group about which information is being sought
B	random sample	**ii**	A small group within a population
C	sample	**iii**	Subjects are selected from a list at regular intervals
D	stratified sample	**iv**	The entire group
E	population	**v**	An official count of an *entire* population
F	survey	**vi**	The sample has the same proportions as the population
G	systematic sample	**vii**	Random numbers are used to select the sample from a numbered list
H	self-selecting sample	**viii**	The process of gathering information from a small group
I	target population	**ix**	Anyone who wishes to participate answers the survey questions.

2 For the following, determine whether each is an example of a random sample, systematic sample, stratified sample or self-selecting sample.

a Viewers voting for their favourite celebrity in a reality TV show
b Selecting every fifth person on a list to participate in a survey
c Using random numbers to select the sample from a list
d Calculating the proportions of subgroups and ensuring the sample has the same proportions

3 Determine whether a census or a survey technique should be used for gathering information in the following situations.

a Determining the number of students in a school
b Finding the preferred menu for a school canteen
c The top 10 downloaded songs for the week
d The number of new cars sold in a week
e The all-time highest point scorer for the Queensland State of Origin team
f The vaccination rates of children in a suburb

4 A touch football club has 460 members. The president wishes to use a systematic sample to survey the members to gauge their support for building a clubhouse. Determine what will be the interval on the list between the members he selects, if he wishes the sample size to be:

a 20 members **b** 50 members **c** 30 members

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Complex Familiar

The following information applies to questions **5** *to* **9**.

A day-care centre has 80 children. The director, Amy, wishes to conduct a survey of the children's parents to see if there is a need to extend the number of hours it offers for outside play. Amy creates an alphabetical list of all the 80 children registered at the centre. She colours the boys' names in blue and the girls' names in orange to be able to distinguish between the gender of the children.

1 Abigail	11 Aria	21 Chloe	31 Ethan	41 Jacob	51 Lily	61 Noah	71 Scarlett
2 Addison	12 Aubrey	22 Christopher	32 Evelyn	42 James	52 Logan	62 Nora	72 Sebastian
3 Aden	13 Audrey	23 Daniel	33 Gabriel	43 Jayden	53 Lucas	63 Oliver	73 Skylar
4 Alexa	14 Ava	24 David	34 Grace	44 John	54 Luke	64 Olivia	74 Sofia
5 Alexander	15 Aver	25 Dylan	35 Hannah	45 Joseph	55 Madison	65 Paisley	75 Sophia
6 Allison	16 Benjamin	26 Elijah	36 Harper	46 Joshua	56 Mason	66 Penelope	76 Victoria
7 Amelia	17 Brooklyn	27 Elizabeth	37 Henry	47 Layla	57 Matthew	67 Riley	77 William
8 Andrew	18 Camila	28 Ella	38 Isaac	48 Leah	58 Mia	68 Samantha	78 Wyatt
9 Anna	19 Carter	29 Emily	39 Isabella	49 Liam	59 Michael	69 Samuel	79 Zoe
10 Anthony	20 Charlotte	30 Emma	40 Jackson	50 Lillian	60 Natalie	70 Savannah	80 Zoey

5 Amy decides to use a random sample technique to select a sample of 15 children to ask their parents to be involved in the survey. Using Excel, she generates the following random numbers.

44	16	7	80	71
2	33	24	31	69
77	19	67	10	17

a Use the random numbers to select the sample to use in the survey.

b Calculate the fraction of the children who attend the day-care centre that are boys.

c Calculate the fraction of the children in the sample that are boys.

d Determine whether the sample is a good representation of the population of children in the centre.

6 Not happy with her sample, Amy then decides to use a systematic sample technique to select the sample. She still wishes to use a sample size of 15.

a Determine how frequently she will select from the list.

b Amy selects a random starting position using Excel. If she starts at 18, determine who will be the children selected for the sample.

c Calculate the fraction of the children in the sample that are boys.

d Decide if the sample is a good representation of the population of children in the centre?

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7 Still not happy with her sample, Amy finally decides to use a stratified sample technique to determine her sample. She reorganises her list to be a list of boys and girls as follows.

1 Aiden	11 Elijah	21 Joseph	31 Oliver	6 Anna	16 Elizabeth	26 Leah	36 Riley
2 Alexander	12 Ethan	22 Joshua	32 Samuel	7 Aria	17 Ella	27 Lillian	37 Samantha
3 Andrew	13 Gabriel	23 Liam	33 Sebastian	8 Aubrey	18 Emily	28 Lily	38 Savannah
4 Anthony	14 Henry	24 Logan	34 William	9 Audrey	19 Emma	29 Madison	39 Scarlett
5 Benjamin	15 Isaac	25 Lucas	35 Wyatt	10 Ava	20 Evelyn	30 Mia	40 Skylar
6 Carter	16 Jackson	26 Luke	1 Abigail	11 Avery	21 Grace	31 Natalie	41 Sofia
7 Christopher	17 Jacob	27 Mason	2 Addison	12 Brooklyn	22 Hannah	32 Nora	42 Sophia
8 Daniel	18 James	28 Matthew	3 Alexa	13 Camila	23 Harper	33 Olivia	43 Victoria
9 David	19 Jayden	29 Michael	4 Allison	14 Charlotte	24 Isabella	34 Paisley	44 Zoe
10 Dylan	20 John	30 Noah	5 Amelia	15 Chloe	25 Layla	35 Penelope	45 Zoey

a Calculate the fraction of the children attending the centre that are boys.

b If Amy still wishes to use a sample size of 15, determine how many boys will be in the sample.

c Use as many of the following random numbers, between 1 and 35, as required to determine the sample of boys.

25 28 20 19 20
4 8 24 32 31

d Calculate the fraction of the children attending the centre that are girls.

e If Amy wishes to use a sample size of 15, determine how many girls will be in the sample.

f Use as many of the following random numbers, between 1 and 45, as required to determine the sample of girls.

15 37 19 3 16
20 28 17 44 29

8 Explain which survey technique provided the best sample for the director.

9 Identify the target population of the day-care director's survey.

Complex Unfamiliar

★10 Amy, the day-care centre director, drafts up the questionnaire that she would like to use for her survey of parents (shown at the top of the next page).

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1	Child's name:	**2** Age:	**3** Gender:
4	Encouraging children to spend time playing outdoors can help their motor, sensory, social and cognitive development. Are you happy with the amount of time your child gets to play outside while attending the day-care centre?		
5	What activities would you like to see offered during outside playtime? (Tick choices.)		
	☐ bikes	☐ rock climbing wall	☐ cricket
	☐ painting	☐ swings	☐ touch football
	☐ sandpit	☐ obstacle course	☐ handball
	☐ monkey bars	☐ laser skirmish	☐ other
6	Does your child eat vegetables?		
	☐ Yes	☐ No	☐ Only when I cover them with tomato sauce.
7	Are you and your partner married?		
	☐ Yes	☐ No	
	Thanks for your time. Please leave this form at the reception desk.		

a Consider Question **4**.
- **i** Questions should be fewer than 20 words long; is the question too long?
- **ii** Identify the words that could be considered jargon.
- **iii** Describe how the question is ambiguous.
- **iv** Rewrite to shorten it and to remove any jargon or ambiguity.

b Consider Question **5**.
- **i** Explain whether this is a reasonable number of choices.
- **ii** Identify any the choices that are not relevant to a day-care centre.
- **iii** Edit the list to make it a more reasonable set of possible responses.

c Consider questions **6** and **7**.
- **i** Determine whether or not Question **6** is a reasonable question to ask in this survey.
- **ii** Determine whether or not Question **7** is a reasonable question to ask in this survey.
- **iii** Identify any problems there might be in asking these questions.
- **iv** Decide whether it is ethical to ask these questions. Explain your reasoning.
- **v** Explain whether or not these questions should be included in the survey.

d Consider the method for collecting the responses. Describe whether this method is going to ensure that the privacy and confidentiality of the parents responding are guaranteed. Otherwise, propose how it could be improved.

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14 Sources of Bias

Maths for a real estate agent: Daniel McNamara

After completing Grade 12, Daniel McNamara studied for a Diploma in Building. After 17 years working in the building industry, he followed his passion for real estate and embarked on a new career as a commercial real estate agent.

Tell us a bit about your job. What does a typical day look like?

I usually try and be organised as much as possible. Managing time is very important in real estate: allowing enough time for clients, relevant paperwork, prospecting, networking, and allowing for phone calls and things that are out of your control can be a challenge. I enjoy speaking with many different people from different walks of life in different industries. Almost every day I meet someone new and learn something new. I can be working on a small lease or a multimillion dollar property transaction. I genuinely get a buzz out of getting a good fair result for all parties involved.

What maths did you study at school?

In senior year I did Maths B. After discussions with my parents, we thought that even if I was leaning towards a trade it was still wise to get an OP (Overall Position rank) and keep my options open.

How do you use maths in your job? Could you give some examples?

Researching the market and providing examples for a prospective seller is very important in real estate. Collating research and making comparisons can help determine the approximate worth of a building. Having the right comparisons and being aware of the size of the land, size of the property, demographics of the area and recent sales all deal with mathematics. As is the case in any industry, managing other people's money is very important and must be done right. Using the correct accountancy programs, entering the data correctly and double-checking procedures is a must. Getting it wrong can land you in jail in real estate!

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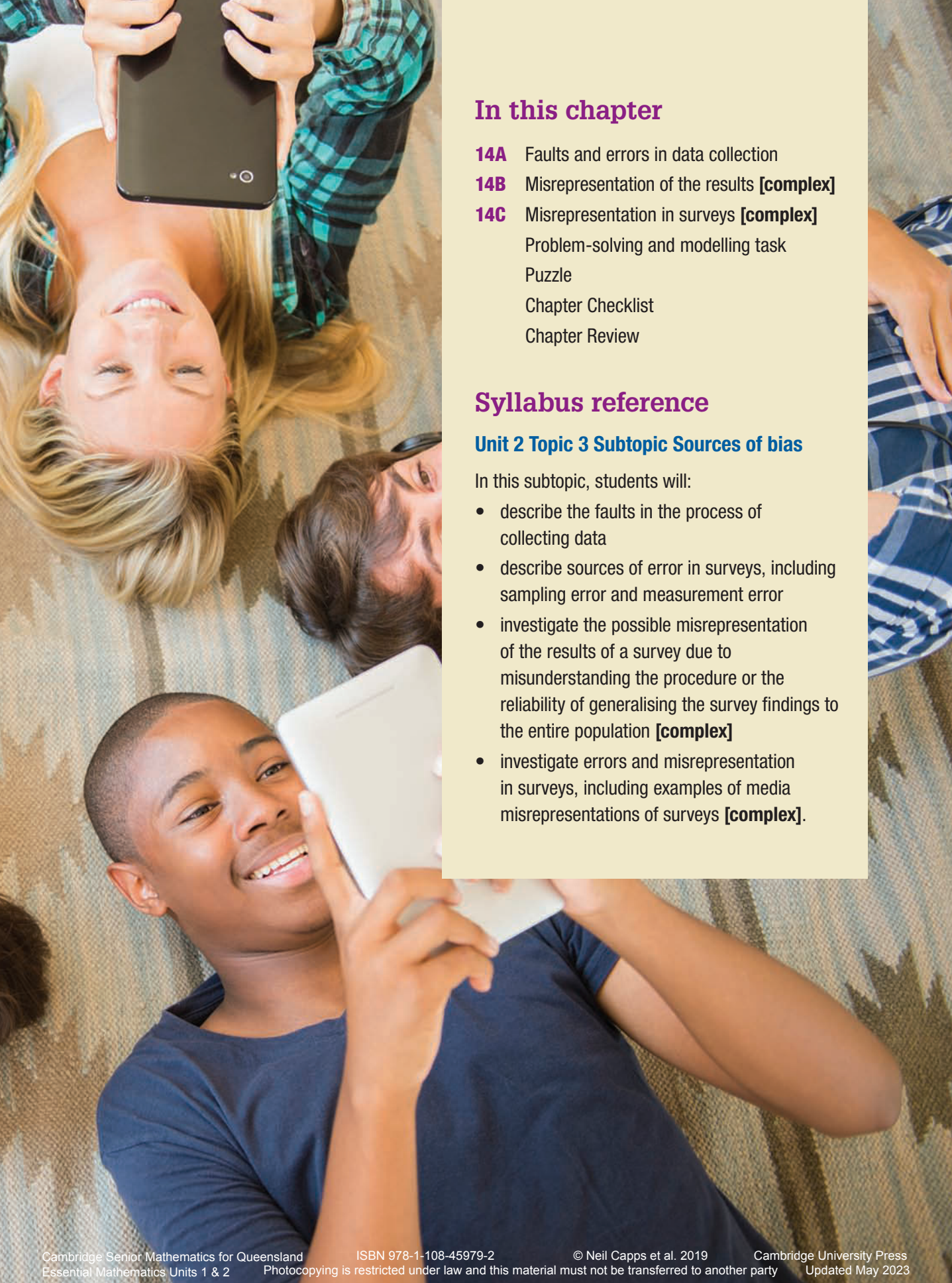

In this chapter

14A Faults and errors in data collection

14B Misrepresentation of the results **[complex]**

14C Misrepresentation in surveys **[complex]**

Problem-solving and modelling task

Puzzle

Chapter Checklist

Chapter Review

Syllabus reference

Unit 2 Topic 3 Subtopic Sources of bias

In this subtopic, students will:

- describe the faults in the process of collecting data
- describe sources of error in surveys, including sampling error and measurement error
- investigate the possible misrepresentation of the results of a survey due to misunderstanding the procedure or the reliability of generalising the survey findings to the entire population **[complex]**
- investigate errors and misrepresentation in surveys, including examples of media misrepresentations of surveys **[complex]**.

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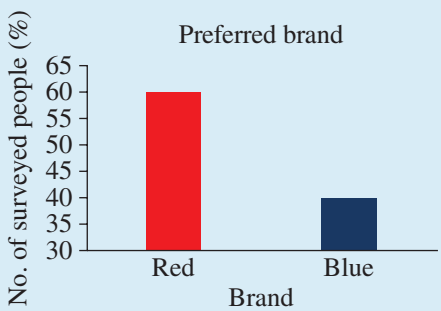
Pre-test

1 Anita wishes to know her school's opinion on the newly built sports facility.

- **a** What would be her target population?
- **b** What is a census, and is it practical for this situation?
- **c** Identify any potential problems in her sample choices, which are:
  - **i** her year group
  - **ii** every third student entering the sports facility
  - **iii** everyone who completes her online survey
  - **iv** asking students randomly during recess and lunch break
  - **v** the administrative staff
  - **vi** a mixture of students, where the students in each year group is in the same proportion as the actual number of students in the school.
- **d** Anita is now considering the questions she will be asking. State whether the following questions have any problems and, if so, identify them.
  - **i** Do you usually go to the sports facility?
  - **ii** Most students like the new sports facility. What do you think of it?
  - **iii** How often do you use the basketball courts, badminton courts, gymnastic equipment, volleyball nets, toilets and change rooms in the new sports facility?
  - **iv** How satisfied are you with the facility? (with response options 'Satisfied' and 'Not satisfied').
  - **v** Would you recommend other students to use the sports facility?

2 A bar graph showing a preferred soft drink brand is given.



- **a** What is the percentage of respondents who prefer brand Red? What about brand Blue?
- **b** List anything that is wrong with the graph.

3 Gabriel wishes to know his electorate's political preference by asking 'Do you like political party A?' with response options 'Yes' and 'No'.

- **a** What is wrong with the question?
- **b** Gabriel asks 10 people who are aged 60 years or older, and finds that 70% like political party A. Explain what is wrong with this sample.
- **c** Gabriel then asks 10 people aged 18 to 30 years. In this group, 30% like political party A. Using both results, what overall conclusion can be made about survey participants' opinion of political party A?
- **d** Are there any issues with Gabriel's overall survey?

A link to a HOTmaths lesson is provided in the Interactive Textbook to revise this topic.

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14A Faults and errors in data collection

LEARNING GOALS

- Describe faults in the process of collecting data
- Identify bias in survey questions
- Identify bias in a sample selection
- Identify bias in measurements

Why is identifying bias essential?

The results obtained from a survey group are supposed to have the same characteristics as the population from which they are drawn. Bias is a tendency to favour one outcome over another. If bias is present in data collection it can influence the outcome of a survey, making it meaningless.

Bias in data makes it meaningless for the purpose it was collected.

WHAT YOU NEED TO KNOW

- Procedures for conducting a survey need to be followed carefully to avoid faults in the process of collecting data. Specifically:
  - **Processing errors** can occur when collating data.
    - For example: Collecting data in the incorrect units.
  - The **target population** needs to be considered when conducting a survey.
    - For example: If the target population is the school student population, then the sample must include students from every year level in the school.
  - Standard **protocols** need to be adhered to.
    - For example: Ask permission to use data collected, declare how the information is going to be used, etc.
- **Bias** occurs when there is a difference between the sample result and the actual population value. Bias can be due to errors in either the **questioning**, **sampling** or **measurement** techniques applied.

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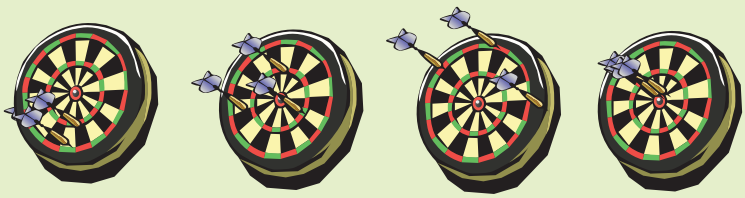
- **Bias in questions** can happen when:
  - The question's wording leads the respondent to a particular answer.
    - For example: We think Papa's Pizza is the best. How great do you think Papa's Pizzas are?
      This question leads the respondent to feel like they also must think that Papa's Pizzas are the best.
  - Questions are written in a positive or negative way.
    - For example: How annoying is it to have to wait for the doctor when you have made an appointment?
      This implies that everyone thinks it is annoying when you must wait at the doctor's while they are attending to a very sick person. This may not be anyone's view except that of the person asking the questions.
  - There is no possibility of giving a particular response.
    - For example: Which sport do you play?
      A netball **B** rugby league **C** volleyball
      What would you answer if you played basketball? Or what if you played no sport at all?
- **Sampling error** can lead to bias when a difference exists between the survey result and the population value due to the sample selected. Sampling error can be attributed to:
  - a mistake
  - **variability** of samples, as different samples can give different results
  - sampling bias, in that a bad sample is chosen
  - small sample sizes have a greater chance of error.
- **Measurement error**
  - When you measure data, you should try and be as accurate and consistent as possible.
  - Accurate means you are as close to the actual value as possible.
  - Consistent means your measured values are close to each other when repeated.
    - For example, when we consider a game of darts:



consistent, not accurate | accurate, not consistent | neither accurate nor consistent | accurate and consistent

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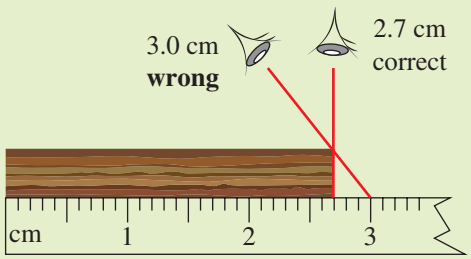
- Errors and faults in measurement may be owing to:
  - systematic error caused by the user making the same error repeatedly or a faulty measuring device (e.g. scales not calibrated to zero)
  - random errors caused by user error. Parallax errors occur when your eye is not directly in line with the mark being measured and leads to variation in the measurements recorded at each trial.



Example 1 Identifying bias in survey questions

These three survey questions are about a stay in a hotel.

1 Rate the cleanliness of your hotel room:
☐ Spotless ☐ Immaculate ☐ Very clean

2 Everyone who stays at our hotel is satisfied. How did you enjoy your stay in our beautiful hotel?

3 How likely are you to recommend to your friends that they should stay at our beautiful hotel?

For each of the questions:

a Describe in what way each question is biased.

b Suggest a new question that does not contain bias.

WORKING	THINKING
1 a No possibility of providing a neutral or negative response if you need to.	There is no possibility of giving a particular response.
b Rate the cleanliness of your room: Poor Average Excellent	
2 a They are telling them what they want to hear back. They also indicate the hotel is 'beautiful'.	The question leads the respondent to a particular answer.
b How did you enjoy your stay in our hotel?	

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WORKING	THINKING
3 a By using 'beautiful' they are being very positive about the hotel and imply you should be too.	Question is written in a positive way.
b How likely are you to recommend to your friends that they should stay at our hotel?	

Example 2 Identifying bias in the selection of samples

Jo wants to conduct a survey of students as part of a Student Representative Council initiative about the food offered at the canteen. She thinks of the following two ways of selecting a sample.

Sample 1: Ask 50 students who are in line at the canteen.

Sample 2: Ask 50 Year 11 students who are sitting in the yard during break.

a Determine if these samples are biased.

b Explain how Jo could ensure she obtains a representative sample of the student population.

WORKING	THINKING
a Sample 1: This sample is biased. The students in line at the canteen are likely to be supportive of the current offerings.	Students who do and do not use the canteen need to be included in the sample.
Sample 2: This sample is biased. Asking only one year group is not ensuring the sample is representative of the whole school.	All year levels and genders need to be represented in the survey.
b To ensure a representative sample, Jo should conduct a random stratified sample.	

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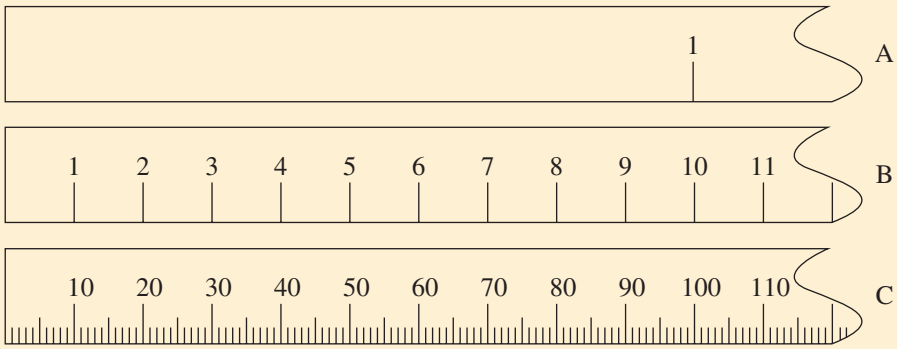
Example 3 Identifying bias in measurements



a Explain which ruler will allow the most accurate measurements.
b Explain what other things the accuracy of ruler measurements could depend on.

WORKING	THINKING
a Ruler C will allow the most accurate measurements.	Ruler C has the most markings or divisions, and therefore the smallest distance between them. It can measure to the nearest millimetre. Ruler A is accurate to the nearest 10 cm and ruler B is accurate to the nearest centimetre.
b Other things accuracy could depend on: • the position of the person measuring, as parallax error needs to be avoided.	Parallax error can be avoided by always placing your eye directly in line with the measurement mark being read.
• Whether the ruler is faulty, e.g. if the zero end is broken off or markings have been rubbed off.	Reasons that a ruler could be a faulty measuring device.

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Exercise 14A

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in the following statements.

- **a** Bias occurs when there is a _____ between the survey result and the actual population value.
- **b** Bias in a question can occur when:
  - **i** the question leads the respondent to a _____ answer.
  - **ii** the question is written in a _____ or negative way.
  - **iii** there is no _____ of giving a particular response.
- **c** _____ error can lead to bias when a difference exists between the survey result and the population value due to the sample selected.
- **d** When you measure data, you should try and be as _____ and _____ as possible to avoid measurement error.

APPLICATIONS

SF: 2–10 | CF: – | CU: 11

Example 2

2 For each of the following samples:

- **i** identify in what way they may have a biased sample
- **ii** suggest a sampling technique to use that would avoid bias.

- **a** Asking people at a Broncos game to state their favourite sport.
- **b** Asking people what is their favourite fast-food outlet while standing in front of a particular fast-food outlet in a food court.
- **c** Surveying people in a retirement home about changes to the age pension.
- **d** Asking people in a shopping centre at 10 a.m. on a Wednesday morning how many hours per week they work.
- **e** Asking the parents what music should be played at a school dance.
- **f** Surveying the price of a loaf of bread at two bakeries, three supermarkets and a local convenience store.
- **g** Surveying 500 people in Brisbane about who they are going to vote for in the federal election.

The time of day and the location can create sample selection bias.

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Example 3

3 Determine which of the following problems could create measurement bias when taking measurements.

- **a** You record 34.9 g rather than 39.4 g.
- **b** You measure people's heights with their shoes on.
- **c** Your ruler has 5 cm broken off the beginning.
- **d** The scales read 150 g when nothing is on them.
- **e** It takes you 0.2 s to click a stopwatch.

Example 1

4 **a** If you wished to conduct a survey about the favourite sports of Year 11 students, identify which of the following questions would you ask.

- **A** Do you play sport?
- **B** What sport do you play at school?
- **C** What sports do you play?
- **D** What sport do you like the most?

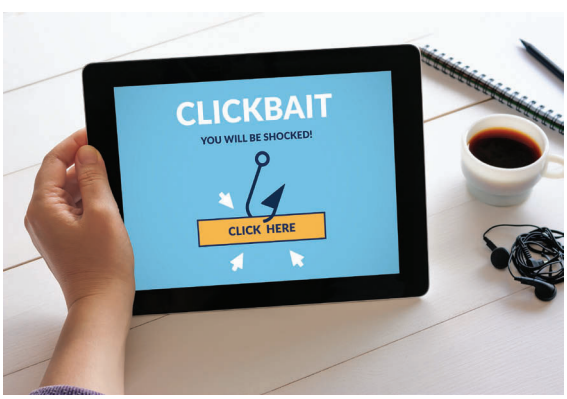
b Identify potential problems with the questions you rejected in part **a**.

★5 For each of the following, rewrite the question so that it does not contain bias.

- **a** I am not in favour of students using their mobile phones at school. What do you think?
- **b** Social media obsession is turning people into antisocial beings. Do you agree?
- **c** Do you prefer to visit the sunny Gold Coast or busy Sydney?
- **d** Do you agree that we should have a sugar tax on those very unhealthy soft drinks?

★6 An internet news website conducted a poll asking people to vote on whether we should have a death penalty in Australia for illegal drug importers. The poll was placed at the end of an article titled 'Drug epidemic in our suburbs'.

- **a** Give reasons why there might be problems with the results of this poll.
- **b** Explain how the poll could be better conducted.



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★7 An online news provider aimed at young people ran an article about the amount of germs found in toilets and how they spread to your mobile phone if you use it while in the toilet. They ran the following poll at the end of the article.

So, do you bring your phone into the bathroom with you?

- ☐ *Yes. What would I do without it?*
- ☐ *Yes, but only I know I'll be sitting on the toilet for a while.*
- ☐ *Ew, literally never.*

The survey yielded the following results.

So, do you bring your phone into the bathroom with you?

47% — 50.4K votes

Yes, but only when I know I'll be sitting on the toilet for a while.

36% — 38.6K votes

Yes. What would I do without it?

17% — 16.2K votes

Ew, literally never.

a Identify how many voters indicated they use their mobile phone while in the bathroom.

b Identify the percentage of respondents that indicated they use their mobile phone while in the bathroom.

c Determine the type of sampling method that has been used in this poll.

★8 A marketing group conducted a survey on social media usage across 800 consumers and 1000 small business owners. Its survey yielded the results given in the table.

Social media use in the home	
84%	Lounge/living room
59%	Bedroom
34%	Kitchen
20%	Study
14%	Bathroom
12%	Toilet

a Identify how many people participated in this survey.

b Identify the percentage of respondents that use their device to check social media when in the bathroom/toilet.

c Determine the type of sampling method that was likely used in this survey.

d This survey yielded very different results from that in Question **7** on the same topic. What reasons could have led to this difference?

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★9 The degree of accuracy depends on the instrument you measure with. A set of digital kitchen scales that measures in whole grams has an error of ±0.5 g. The kitchen scales shown in the image displays a weight of 47 g for the items being weighed.

a Calculate the smallest weight the items could be.

b Calculate the largest weight the items could be.

c Identify which of the following might be the actual weight of the items.
47.6 g 46.7 g 46.4 g 47.3 g 47.0 g

★10 Consider this blue line:

a Determine the length of the line when you measure to the nearest millimetre.

b Determine the length of the line when you measure to the nearest centimetre.

c Determine the size of the measurement error when centimetres instead of millimetres are used to measure the line.

d Calculate the percentage measurement error when centimetres instead of millimetres are used to measure the length of the line.

11 Three Science students measured the weight and volume of the same piece of metal to determine the density of the metal. The results of three trials are presented in the table.

	Harry	Craig	Patrick
Trial 1	23.14 g/mL	23.56 g/mL	23.03 g/mL
Trial 2	23.13 g/mL	23.56 g/mL	23.54 g/mL
Trial 3	23.17 g/mL	23.55 g/mL	23.25 g/mL
Average	23.15 g/mL	23.56 g/mL	23.27 g/mL

a Explain which student you think is least accurate when measuring the metal.

b Explain which student is the most consistent when measuring the metal.

c Explain which student is most accurate and consistent when measuring the metal.

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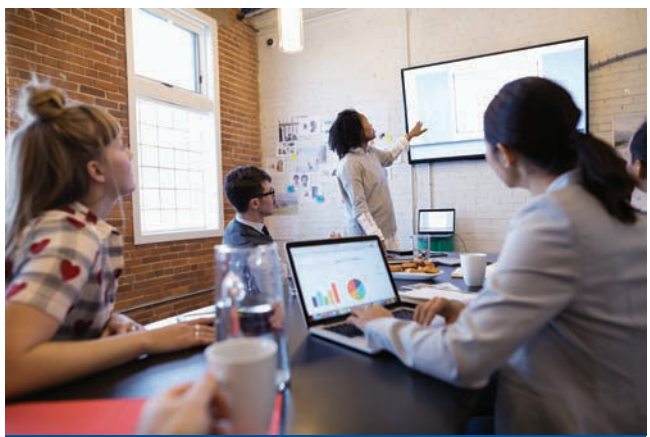
14B Misrepresentation of the results COMPLEX

LEARNING GOAL

- Identify issues that arise when applying the results of a survey to make generalisations about a population.

Why is being aware of misrepresentation of results essential?

Statistics can be very useful for helping us to understand characteristics in a population. Not using good sampling and not questioning procedures can lead to biased results that do not represent the population we are trying to make a generalisation about. Care must be taken when interpreting statistical data and making generalisations about a population.



Care must be taken when applying the results of a sample to make generalisations about a population.

WHAT YOU NEED TO KNOW

- As discussed in Chapter 13, **sampling techniques** must be applied carefully to avoid bias in the data collected. Common sources of bias in sampling can be:
  - **Self-selection bias**, which results from voluntary survey respondents who are mostly interested in a particular outcome of a topic so one viewpoint can be over-represented.
  - **Non-response bias**, which results from a difference between those who do and do not respond to the survey.
    - For example: In a study of newborn children, the parents who responded again after 1 year corresponded with the income level of the parents.
  - The sample is **not representative** of the population.

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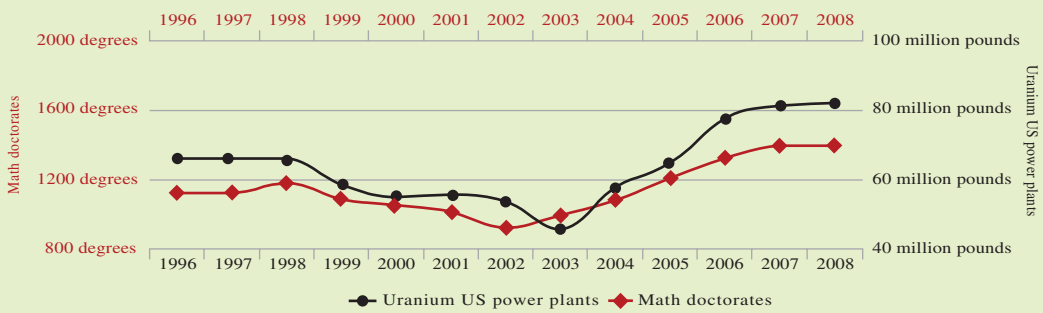
- **Procedures** for conducting a survey also need to be followed carefully to avoid bias. Specifically:
  - **Interviewer bias**, which can occur when the interviewer influences responses either deliberately or not.
  - **Questionnaire bias**, which can happen when the questions are not designed carefully.
  - **Processing errors**, which can occur when collating data.
- When interpreting data, care must be given to avoid common errors of thinking.
  - **Don't assume small differences are significant.**
    - For example: A 1% change in people's preferred prime minister does not necessarily mean that a particular political party will win the next election. It could just be the result of a variation between samples.
  - **Ignore coincidence.** Sometimes completely unrelated statistics have common trends.
    - For example: The number of Mathematics doctorates (PhDs) awarded has no relationship with the amount of uranium stored at US nuclear power plants. But, according to the following graph, they do.



Source: www.tylervigen.com/spurious-correlations

  - **Don't get cause and effect backwards.** When two things are related, care must be taken when identifying which is the cause and which is the effect.
    - For example: Consider depression and unemployment. Can depression lead to unemployment or is it the other way; that is, unemployment can lead to depression?
  - **Don't forget to consider outside causes.** There can be a third factor causing a certain relationship.
    - For example: Students at a particular school may perform better than the State average on exams. One could think that attending that school leads to better results. It could be that the school is in a wealthy suburb and parents are able to afford tutors for the students, which leads to the above-average results.

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Example 4 Misrepresentation of results

Penny surveyed 20 students in Year 11 about how long they spent on homework the night before. Fourteen students replied that they did more than 4 hours. Penny then reported to the Deputy Principal that '70% of students at the school have too much homework'.

a Identify any issues with the sampling technique.
b Identify any issues with the survey procedure.
c Identify any issues with the interpretation of results.

WORKING	THINKING
a The sample is not representative of the entire school population and consists of only 20 students from one year level.	The sample should cover all year levels and be larger.
b The question asked how long students had spent on homework the night before. It did not ask if the student felt they had too much homework or how many hours they usually do per night.	Questions should ask what you want to know.
c It could have been that a Maths assessment was due that day for Year 11 and many students stayed up late the night before finishing it. The students might not usually do more than 4 hours of homework per night.	Outside causes can have an influence on the results.

Exercise 14B

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in the following statements.

a Sampling techniques need to be carefully _____ to avoid _____.
b Procedures for conducting a survey must be followed carefully to avoid bias. Specifically, _____ bias; _____ bias; and processing _____.
c When interpreting data, care must be given to not _____ small differences are significant; not to ignore_____; don't get cause and effect _____; and don't forget to consider _____ causes.

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APPLICATIONS

SF: – | CF: 2–6 | CU: 7–11

Example 4 ★2 A company sends an email to all its customers following an online purchase, asking them to complete a survey.

a 46% of customers respond to the survey. Identify any issues with the sampling technique.

b For the survey question 'How satisfied are you with our service?' customers could respond either 'Very satisfied' or 'Somewhat satisfied'. Identify any issues with the survey procedures.

c In a report to the shareholders, the company wrote that '100% of our customers are satisfied with our service'. Identify any issues with the interpretation of the results.

★3 An online newsagency ran a poll asking readers 'Which do you prefer: A summer barbeque or a Christmas party?'. 61% of respondents voted for a summer barbeque.

a Identify the type of sampling technique that has been used.

b Identify the issues that could arise from generalising the results of this survey to the population.

★4 Joel asks 10 kids lined up at his club's kiosk if they like the food being sold at the kiosk. All 10 students say they like the food that is sold at the kiosk. Joel reports to the Kiosk Manager that 100% of kids at the club like the food sold at the kiosk.

a Identify the issues that might arise from the sampling technique that Joel has used?

b Identify the issues that could arise from the reporting of the data?

★5 Lachlan surveys his classmates, asking them 'Are you a fan of the Brisbane Bronco's NRL team like me?'.

a Identify the issues that might be present in the survey procedure.

b Explain what Lachlan could do to improve his survey procedure.

★6 When recording the number of hours classmates had completed as a Learner Driver, Libby accidently recorded Grace's entry of 18 hours as 81 hours.

a Identify the type of procedural error that has occurred.

b Explain what impact this will have on the survey's results.

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★7 When following the ASX share market, Jeff noticed that the share price of a company had increased 15 cents in the past day (see table).

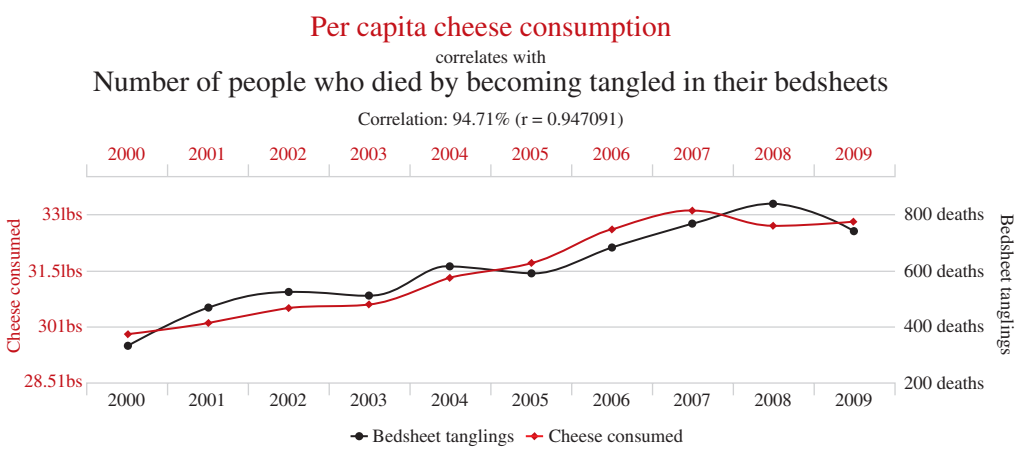
Date	Last
09/03/2018	21.760
08/03/2018	21.610

a When interpreting this data, what should Jeff consider?

Jeff decides to look at the last three months' share prices.

b By analysing the share prices over a longer period, explain whether or not the company seems as appealing to invest in.

★8 The graph shows the relationship between cheese consumption and the number of people who died by becoming tangled in their bedsheets over the same time period.



Source: www.tylervigen.com/spurious-correlations

a Describe an error of thinking that could occur when interpreting this data.

b Give an example of a problematic conclusion from this graph.

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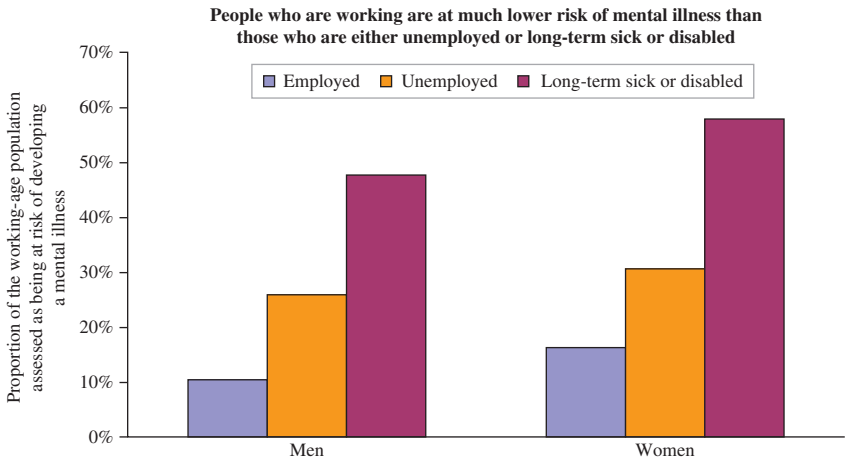
★9 Consider this graph, which shows a relationship between employment and mental illness.



Source: British Household Panel Survey, University of Essex, Institute for Social and Economic Research; the data is the average for the five years to 2008/09; updated July 2010.

a The title gives a strong opinion on the causes of mental health. Determine the issue with the interpretation of the data.

b When interpreting the graph, explain if it is reasonable to assume:

A mental illness affects employment; or

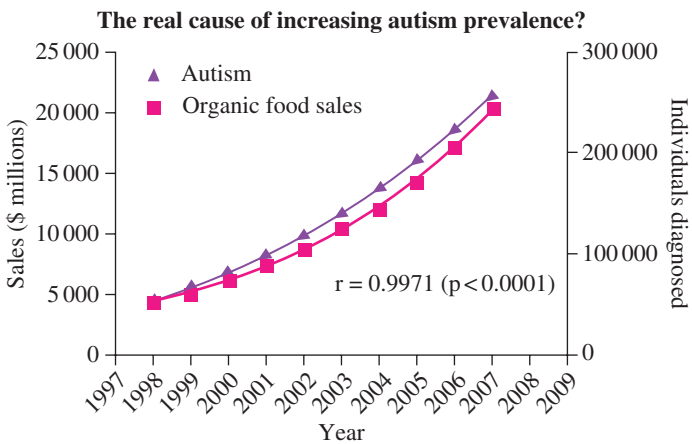
B employment affects mental illness.

c Suggest a better title for the graph.

★10 This graph was printed under the heading 'The real cause of increasing autism prevalence?'.

a Identify any issues with the interpretation of this data as implied by the title.

b Identify an outside cause that might have influenced the growth in both statistics.



Source: www.cracked.com/article_20318_the-5-most-popular-ways-statistics-are-used-to-lie-to-you.html

★11 A study published in 2018 found that breastfed babies grew up to have a 3.7 point higher IQ, more years of education and earn 20% more than the average income by the time they are 30 years old. (https://edition.cnn.com/2015/03/18/health/breastfeeding-iq-income/index.html)

a What the issue with the interpretation of this data.

b Identify an outside cause that might have influenced the statistics.

c Explain a possible danger of this interpretation of the data.

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14C Misrepresentation in surveys COMPLEX

LEARNING GOAL

- Investigate errors and misrepresentations when reporting surveys

Why is identifying misrepresentation in surveys essential?

We have all heard the statement 'There are lies, damned lies and statistics'. Sadly, statistics can be used to mislead from time to time. This can happen by manipulating results to give a false impression of facts. It is important to be aware of possible misrepresentation of results when applying the results of a survey to generalisations about a population.

Statistics can be used to mislead.

WHAT YOU NEED TO KNOW

Survey results can be misrepresented to give a different impression of the characteristics of the population.
Common methods of misrepresentation to watch out for are:

- **Misleading graphs**, as discussed in Chapter 5.
- **Omitting data** that does not suit the agenda of the author.
- Leaving survey questions out of a report can lead to **incorrect conclusions** being made about the data.
- **Averages** can be influenced by a few small or large pieces of data.
  - For example: 1, 2, 3, 4, 5 has an average = 3; but 1, 2, 3, 4, 40 has an average = 10. One number was able to make a significant difference to the average calculated.
- **Misuse of percentages.** When claiming a 'fastest growing' group, writers generally use percentages to support their claim.
  - For example: If a rare disease has four people affected by it and one more diagnosis is made, a 25% increase can be claimed. But, really, how significant is the increase?
- Exaggeration or misrepresentation of **cause and effect**, as discussed in Section 14B.

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Example 5 Correlation vs causation

The number of people rescued in surf rips and the number of people who were involved in car accidents both rose in Queensland during January. Identify which of the following could be a possible explanation.

A Surf rips cause car accidents.
B Car accidents cause surf rips.
C Surf rips and car accidents partly cause each other.
D Surf rips and car accidents are caused by a third factor.
E The correlation is purely by chance.

WORKING	THINKING
We would expect both statistics to increase during the summer months when more people are at the beach and on the road for holidays. Therefore, option D, a third factor (i.e. summer), is a possible explanation for the correlation.	Are the statistics related in any way?

Example 6 Omitting data

During an election campaign, some polls show Smith to be ahead by 5% and one shows Jones to be ahead by 2%. During a rally Jones tells his supporters, 'The polls show we are sure to win this election as I am ahead by 2%.'
How does this statement misrepresent the survey results?

WORKING	THINKING
Jones has omitted data that does not suit his cause.	He has used statistics that are only favourable to him.

Exercise 14C

FUNDAMENTALS

1 Demonstrate your understanding of terms by writing down the missing words in the following statements.

a Survey results can be _____ when reporting results to give a different _____ of the characteristics of the population.

b _____ graphs can give a false impression of data.

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c Omitting _____ that does not suit the agenda of the author is a technique designed to _____.

d Leaving survey questions out of a report can lead to _____ conclusions being made about the data.

e Averages can be influenced by a few _____ or _____ pieces of data.

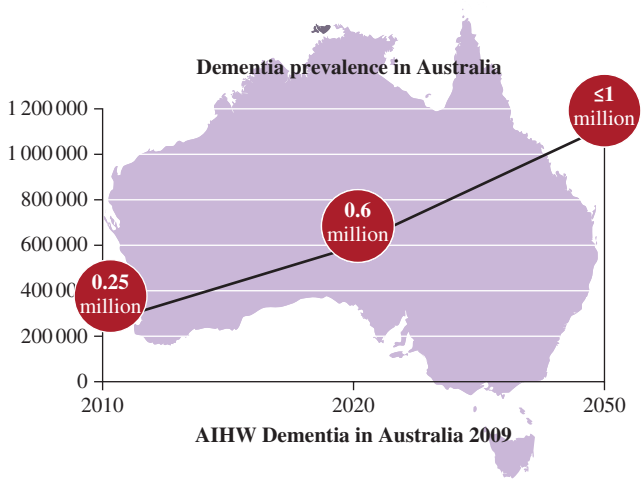
f When claiming a 'fastest growing' group, writers are generally using _____ to support their claim.

APPLICATIONS

SF: – | CF: 2–4 | CU: 5

Example 5

2 Behind heart disease, dementia is the second leading cause of death in Australia today. This graph shows the anticipated prevalence of dementia in Australia, without any medical breakthrough to find a cure.



a Use the graph to determine the predicted number of dementia sufferers by:

i 2020

ii 2050 if you read the bubble

iii 2050 if you read the line graph.

iv Identify the mistake that has been made with the reading recorded in the bubble.

b In 2010 the population of Australia was 22.3 million people.

i Use the graph to determine how many people suffered from dementia.

ii Calculate the percentage of the population that suffered from dementia.

c In 2020 the population of Australia is expected to reach 24.0 million people. According to the graph:

i Use the graph to determine how many people are expected to have dementia.

ii Calculate the percentage of the population that is expected to be suffering from dementia.

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d The population is expected to reach 35.9 million by 2050.
- **i** Use the graph to determine how many people are expected to have dementia.
- **ii** Calculate the percentage of the population that is expected to have been diagnosed with dementia in 2050.

e Give a possible cause for the expected increase in the number of people diagnosed with dementia.

f Describe two ways that the graph misrepresents the data.

g Construct another graph to represent this data with percentages on the vertical axis, and the same horizontal axis. Use the percentage of population calculations from parts **b ii**, **c ii** and **d ii**.

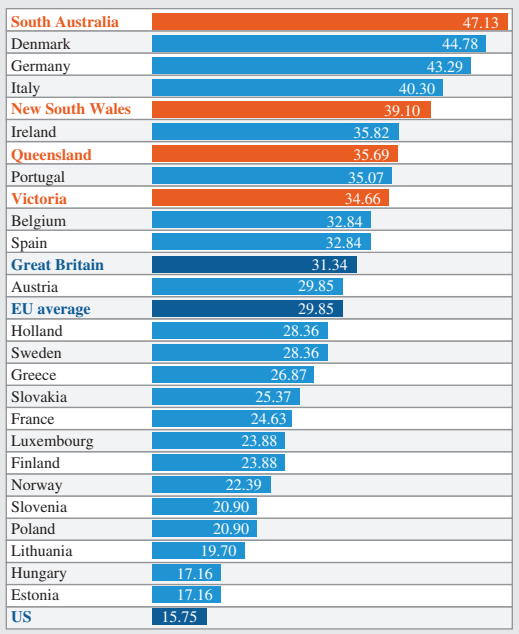
3 *The Financial Review* reported in August 2017 that 'Australian households pay the highest power prices in the world.'
An excerpt from the article is given.

Australian residential customers are paying the highest electricity prices in the world – two to three times more than American households – but experts say they need more than information to navigate the thicket of discounts and offers.

South Australian households are paying the highest prices in the world at 47.13c per kilowatt hour, being more than Germany, Denmark and Italy, which heavily tax energy, after the huge increases on July 1, Carbon + Energy Markets' MarkIntell data service says.

NSW households typically pay 39.1c per kWh – hard on Italy's heels – while Queensland and Victoria's typical retail charges of 34.7c to 35.7c per kWh exceed those in all but the four or five most expensive European countries, the MarkIntell data shows.

Retail electricity prices of NEM states, including taxes, compared to selected countries (¢ per kWh)



Source: www.afr.com/news/australian-households-pay-highest-power-prices-in-world-20170804-gxp58a

a Use the graph to determine how much consumers are paying per kWh in:
- **i** the US
- **ii** South Australia
- **iii** Queensland

b Calculate the ratio of prices for:
- **i** South Australia to the US
- **ii** Queensland to the US

c Use your answers to part **b** to verify the claim in the first paragraph that Australian residential customers are paying 'two to three times more than American households'.

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d Measure the length of the bar on the graph for:
- **i** the US
- **ii** South Australia
- **iii** Queensland

e Calculate the ratio of bar lengths for:
- **i** South Australia to the US
- **ii** Queensland to the US

f Use your answers to complete the following.
- **i** Compare your ratios found in part **e** to those found in the article and in part **b**.
- **ii** Explain whether the claims in the article are consistent with the statistics and the graph.
- **iii** Identify a possible reason for any difference.

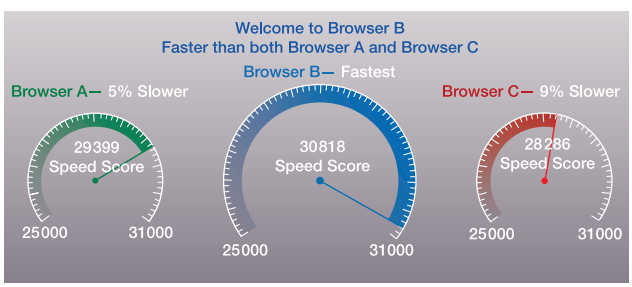
g Explain how the following factors could make a difference to the average prices quoted.
- **i** sample size
- **ii** using the mean vs the median
- **iii** how the sample was collected
- **iv** how the electricity was generated – gas, coal, solar, hydroelectricity

Example 6 ★4 A local council collected data on the number of development applications it had approved. It showed that from 2011 to 2014 the number of development applications had increased, from 2014 to 2016 the number of applications had remained steady, and in 2017 the number of applications had dropped. In an advertising campaign designed to promote the region, the council stated, 'Development applications have risen significantly from 2011 to 2017.'

a Identify the way in which the Council has misrepresented the survey's results.

b Explain the purpose of misrepresenting the data.

★5 The following graph appeared when installing computer software.



a Identify two ways in which the graph is misleading.

b Construct a histogram to represent the information.

c Check the calculated percentage change between Browser B and:
- **i** Browser A
- **ii** Browser C.

d Is there any indication of the number of trials conducted in the survey? What factors about the sample might influence the results?

e Is there any indication how the data was calculated? Would you get the same result if an average or a median score were used?

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Problem-solving and modelling task

HOW OFTEN ARE AUSTRALIANS USING THEIR PHONES WHILE DRIVING?

Background: ABC news reported on its website in December 2017 that 'Young workers most likely to use phones while driving'.

An extract from the article is given.

> *Distracted driving is a significant contributor to road accidents and fatalities. Mobile phone use while driving is a particularly important form of driver distraction.*
>
> *It can increase the risk of traffic accidents by up to four times.*
>
> *At any moment, roughly 1–2 per cent of Australian drivers are using their mobile phone while driving. In 2016 alone, police in New South Wales charged 39,000 people for doing so.*
>
> *Our survey of 413 South Australians revealed that young working people were those most likely to use their phones while driving.*
>
> ***How prevalent is it?***
> *One in three respondents in our survey reported never using their phones while driving; one in two reported rare or occasional use; and one in five reported frequent use.*
>
> *Receiving incoming phone calls while driving was the most commonly reported behaviour: 61 per cent reported having received at least one call while driving in the past two weeks.*

Task: The article makes a claim that 'at any moment, roughly 1–2 per cent of Australian drivers are using their mobile phone'. You are to verify or refute (disprove) this statistic.

To complete this task, follow the problem-solving workflow diagram on the next page and use the steps listed as a guide.

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Stage 1: Formulate

1 What are you required to do?
2 What information do you have?
3 What other information do you need?
4 How could you gather more information?
5 What assumptions will you make?

Stage 2: Solve

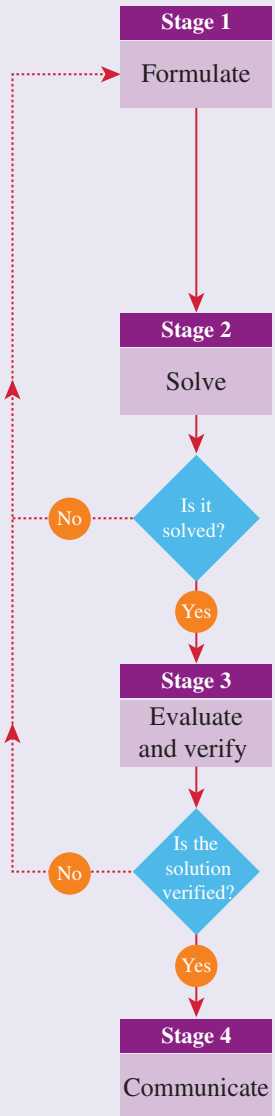
6 Gather more information through research or a survey.
7 Estimate the percentage of Australians driving and using a phone at any moment.
8 Produce graphs and/or tables required to help solve the problem.
9 Decide whether you can verify or refute the statistic quoted.

Stage 3: Evaluate and verify

10 Have you verified or refuted the statistic?
11 Do you have the evidence to back up your decision?

Stage 4: Communicate

12 Write a report with an introduction, body and conclusion.
- State your main point.
- Include the evidence in the form of statements, graphs and tables. Explain the evidence. Use a sentence starter like 'This means…'.
- In the conclusion, link back to your main point.



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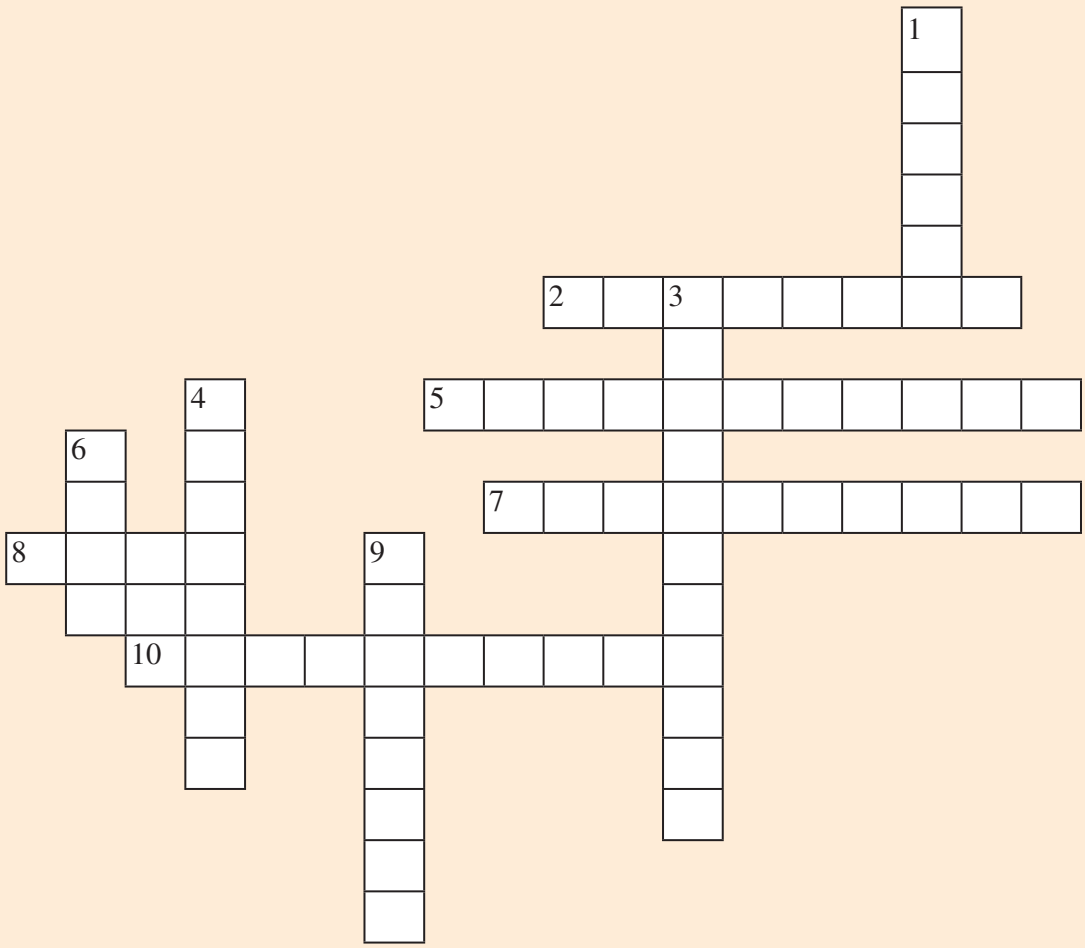
Puzzle



Across

2 When your measurement is close to the actual value

5 Small differences in results are not always ____.

7 Faults can happen if proper ___ are not followed when collecting data.

8 Poor techniques can lead to ___ in the data collected.

10 Selecting a bad sample leads to a ____ between the sample and target populations.

Down

1 When finding relationships between data, identify the cause and the ____.

3 Unrelated statistics can have common trends due to ____.

4 Bias can happen when we ask a poor ____.

6 Leaving out data to influence results

9 When your measurements are consistently close to each other

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Chapter checklist

☐ I can describe faults in the process of collecting data.

1 A government committee set up an online poll to assess the public's view on immigration. It distributed the link to the poll via social media sites and people were able to vote multiple times using different email addresses. People from outside Australia responded to the poll and promoted it widely on the internet.

a Give reasons why there might be problems with the results of this poll.

b Suggest how the poll could have been conducted better.

☐ I can describe sources of errors in surveys, including sampling error and measurement error.

2 A TV show asks viewers their opinions on an issue, through its Facebook page.

a Explain in what way the TV show might have a biased sample.

b Indicate a sampling technique to use that would avoid bias.

3 A set of bathroom scales always shows 0.2 kg when no one is standing on them. What type of error would be created when using these scales?

☐ I can identify misrepresentation of a survey's results due to misunderstanding the procedure or the reliability of generalising the survey findings to the entire population [Complex].

4 An online news agency ran a poll asking readers, 'Which do you prefer: free-to-air TV or on-demand-streaming?' 87% of respondents voted for streaming.

a What type of sampling technique has been used?

b What issues could arise from generalising the results of this survey to the population?

- When interpreting data, be careful not to:
  - Assume small differences are significant
  - Ignore coincidence
  - Get cause and effect backwards
  - Forget about outside causes.

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☐ I can identify errors and misrepresentation in surveys, including in the media.

5 A news article has the headline: **'Alarming' survey results show Australians are suffering from a 'loneliness crisis'**. The story went on to say that *it's 'alarming' 15% of men and 8% of women say they have no close relationships outside of their intimate relationship and 18% of Australians feel they can't reach out to neighbours in a time of crisis.* The article also said *social media is playing a large role. 'We know people can have 300 friends on Facebook and if you're home alone on a Saturday night and you're looking through your feed and everyone's having a party out there, there is nothing more isolating.*
(Source: www.4bc.com.au/alarming-survey-results-show-australians-are-suffering-from-a-loneliness-crisis/)

a In what way could the headline be misleading?

b In what way has the article misrepresented the statistics?

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Chapter review

All questions in the Chapter Review are assessment-style.

Simple Familiar

1 Jim wishes to surprise his teenage son by purchasing him a new gaming console. He surveys his colleagues at work for advice on which platform to buy.

- **a** Describe a fault in Jim's method of collecting data.
- **b** Explain how Jim could improve his survey.

2 Customers at a local hardware store were asked in a survey 'How many times have you visited this hardware store in the past year?'.

- **a** Is this an example of questioning error, sampling error or measurement error?
- **b** Identify in what way there is an error.
- **c** Describe how the question could be improved?

3 When conducting a poll on how our taxes are spent, give reasons for which question should be used.

- **A** Do you believe that you should be taxed so other people do not have to work?
- **B** Do you think the government should help people who cannot find work?
- **C** Do you support the government's assistance programs for the unemployed?
- **D** What do you think about unemployment assistance?

4 When measuring the heights of students in her class, Mrs Tall used an old height chart that measured in inches (2.54 cm) and she measured to the nearest inch. She also asked students to keep their shoes on. Describe any faults in her method of collecting data.

5 When deciding where the staff Christmas party should be held for Hawking SHS, the Social Club Coordinator, who happens to be the Essential Maths teacher, Mr Evans, asked the six other Maths teachers for their preferred venue. The staff body consists of teachers, learning support assistants, cleaners, groundsmen and administration assistants. Identify any errors with Mr Evans' method of collecting data.

6 Mr Evans' question to the other Maths teachers was, 'I'd really like to hold the staff Christmas party this year at Trinomial Tavern. Do you think that is a good place?'. Suggest a new question that does not contain bias.

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7 Consider this line:

a Use a ruler to determine the length of the line when you measure to the nearest millimetre.
b Use a ruler to determine the length of the line when you measure to the nearest centimetre.
c Calculate the size of the measurement error when centimetres instead of millimetres are used to measure the line.
d Calculate the percentage measurement error when centimetres instead of millimetres are used to measure the length of the line.

8 A mother weighs her child to check her child's growth. The scales' reading is shown in the photo.

a Identify the weight reading, in kilograms (kg).
b Calculate the weight reading, in grams (g).
c Choosing from 1 kg, 1 g, 10 g or 100 g, complete this statement:
The scales are accurate to the nearest _____.
d Determine the lightest possible weight of the child, in grams.
e Determine the heaviest possible weight of the child, in grams.
f Determine the error range for the scales.
g The child's weight, to the nearest gram, is 11 168 g. Calculate the percentage error.

Complex Familiar

9 A cricket phone app polled its subscribers on who is the greatest batsman of all time. This happened as a very popular player was approaching a double century (200 runs) and the game was being televised live around the country. Describe any sources of error in this poll.

10 Regina surveyed eight parents, who were watching their child play volleyball in a school team, about how many hours a week their child spent playing sport. Six parents said their child played only volleyball and spent an hour training and 1 hour at the game each week. Regina reported to the sports master that '75% of parents felt the teams needed more training'.
a Identify any issue with the sampling technique.
b Identify any issues with the survey procedure.
c Identify any issues with the interpretation of the results.

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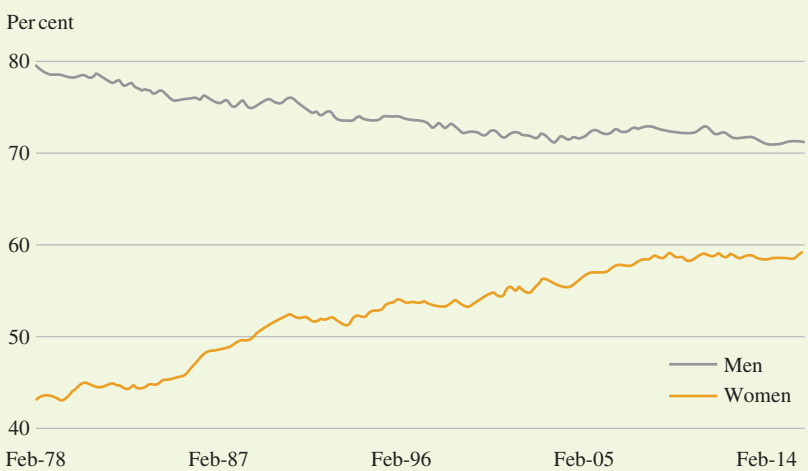
Complex Unfamiliar

11 A school tracked its students' results from Year 7 to Year 10 and found an improvement in the average academic performance of the students. The following statistics were also observed over the same time period.

- **A** An increased number of students using BYO laptops at school.
- **B** A decrease in the number of students buying lunch from the tuckshop.
- **C** An increase in the number of students accessing help from teachers during lunch breaks and after school.
- **D** A decrease in the number of students using their phones at school, after the implementation of a policy banning mobile phones at school.
- **E** An improvement in the performance of the basketball team for that age group.

For each of the data trends **A** to **E**, decide if it could be an influencing cause on the students' improved academic performance. Give reasons to support your answer

12 The following graph was part of a report on labour force statistics presented to the Parliament of Australia in 2015. The graph shows the participation rate in the workforce from 1978 to 2014, according to gender. Essentially, it is showing the percentage of men and women, aged 15 years and over, engaged in work over the time period.



Suggest a possible interpretation of the data shown in this graph.

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13 Below is an excerpt from an article that appeared in the *Sydney Morning Herald* 16 March 2018.

Death traps: Push to phase out cars made before 2002

Vehicles older than 15 years — many lacking lifesaving airbags or electronic stability control — should be phased out to reduce road deaths, according to a leading non-profit safety ratings group.

The call by the Australasian New Car Assessment Program (ANCAP) came after a review of road fatalities over the past three years.

The rate of fatal crashes for vehicles 15 years and older was four times greater than for occupants in vehicles made in the past five years, crash data from 2014 to 2016 shows.

The research by ANCAP found that the average age of cars and sports utility vehicles involved in fatal crashes rose gradually from 12.5 years old in 2014 to 12.9 in 2015 and 13.1 in 2016. At the same time, the average age of Australian passenger cars stayed the same at 9.8 years old.

a Determine the increase in the age of cars and sports utilities involved in fatal car accidents between 2014 and 2016. Is this a large change? Identify factors that could influence the calculation of the average.

b The article states: 'The rate of fatal crashes for vehicles 15 years and older was four times greater than for occupants in vehicles made in the past five years.' Describe any other factors that could lead to the increase in car accidents in older cars.

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Answers

Chapter 1

Chapter 1 Pre-test

1 **a** 40 **b** 18 **c** 27
d 6 **e** 4 **f** 8
2 **a** $\frac{1}{2}$ **b** $\frac{2}{3}$ **c** $\frac{3}{4}$
d $\frac{1}{4}$ **e** $\frac{5}{7}$ **f** $\frac{5}{8}$
3 **a** 9 **b** 27 **c** 30
4 **a** 0.25 **b** 36 **c** 2.5
d 750 **e** 2300 **f** 3600
5 **a** $\frac{1}{4}$ **b** $\frac{2}{13}$ **c** $\frac{1}{2}$
d $\frac{2}{5}$ **e** $\frac{5}{12}$ **f** $\frac{1}{20}$
6 **a** \$15 **b** \$75 **c** \$40
7 **a** 6 **b** 20 **c** 3
8 **a** 12 **b** 60 **c** 30
9 **a** 2 : 1 **b** 3 : 1 **c** 5 : 3

Exercise 1A

1 **a** order **b** same
c units **d** same
2 **a** **i** 7 : 9 **ii** $\frac{7}{16}$ **iii** 9 : 16
b **i** 6 : 9 **ii** $\frac{6}{15}$ **iii** 9 : 15
c **i** 8 : 12 **ii** $\frac{8}{20}$ **iii** 12 : 20
3 **a** Part 1 = 2
Part 2 = 3 − 2 = 1
Ratio = 2 : 1
b Part 1 = 8
Part 2 = 13 − 8 = 5
Ratio = 8 : 5
c Part 1 = 22
Part 2 = 37 − 22 = 15
Ratio = 22 : 15
d Part 1 = 45
Part 2 = 78 − 45 = 33
Ratio = 45 : 33
e Part 1 = 15
Part 2 = 22 − 15 = 7
Ratio = 15 : 7
f Part 1 = 9
Part 2 = 14 − 9 = 5
Ratio = 9 : 5
g Part 1 = 14
Part 2 = 19 − 14 = 5
Ratio = 14 : 5
h Part 1 = 7
Part 2 = 12 − 7 = 5
Ratio = 7 : 5
4 **a** Total parts = 3 + 5 = 8
New ratio with fractions = $\frac{3}{8} : \frac{5}{8}$
b Total parts = 6 + 11 = 17
New ratio with fractions = $\frac{6}{17} : \frac{11}{17}$
c Total parts = 31 + 211 = 242
New ratio with fractions = $\frac{31}{242} : \frac{211}{242}$
d Total parts = 42 + 77 = 119
New ratio with fractions = $\frac{42}{119} : \frac{77}{119}$
e Total parts = 7 + 15 = 22
New ratio with fractions = $\frac{7}{22} : \frac{15}{22}$
f Total parts = 8 + 17 = 25
New ratio with fractions = $\frac{8}{25} : \frac{17}{25}$
g Total parts = 9 + 5 = 14
New ratio with fractions = $\frac{9}{14} : \frac{5}{14}$
h Total parts = 57 + 36 = 93
New ratio with fractions = $\frac{57}{93} : \frac{36}{93}$
5 **a** Student : teacher; i.e. 12 students for every 1 teacher.
b For every 3 units of flour there will be 2 units of sugar.
6 **a** 5 : 8 **b** 3 : 5
c 11 : 14 **e** 8 : 11
d 7 : 12 **f** 4 : 5
7 **a** 8 : 9 **b** 9 : 14
c 14 : 17 **d** 8 : 9 : 14
8 **a** 26 : 26 **b** 13 : 26
c 13 : 39 **d** 4 : 48
9 40 : 3
10 **a** Ratio is 6 : 1, therefore there would be six children and one coach.

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b If Konrad excludes himself, there will be five other children during his training session.

11 Answers will vary but approximately 1 : 8.

12 Answers will vary.

13 Answers will vary depending on the length of hands and feet; e.g. 10 cm : 15 cm.

Exercise 1B

1 **a** HCF, exactly **b** dividing, HCF
c dividing, HCF **d** LCD, exactly
e LCD

2 **a** 8 : 8 = 1 : 1
b 12 : 8 = 3 : 2
c 12 : 12 = 1 : 1

3 **a** **ii** 4 : 22 = 2 : 11
b **iii** 13 : 39 = 1 : 3
c **iv** 35 : 25 = 7 : 5

4 **a** 5 **b** 7 **c** 3 **d** 12
e 7 **f** 12 **g** 9 **h** 6
i 12 **j** 22 **k** 35 **l** 25

5 **a** $\frac{1}{2}$ **b** $\frac{1}{4}$
c $\frac{1}{3}$ **d** $\frac{2}{3}$
e $\frac{2}{3}$ **f** $\frac{13}{25}$ (already in simplest form)
g $\frac{2}{3}$ **h** $\frac{5}{6}$
i $\frac{5}{8}$

6 **a** 1 : 3 **b** 1 : 2 **c** 1 : 3
d 1 : 4 **e** 3 : 5 **f** 2 : 3
g 2 : 5 **h** 1 : 3 **i** 2 : 9
j 4 : 1 **k** 27 : 8 **l** 3 : 5

7 **a** 1 : 3 : 6 **b** 1 : 4 : 5 **c** 1 : 3 : 5
d 4 : 6 : 9 **e** 3 : 4 : 10 **f** 4 : 9 : 16
g 2 : 5 : 7 **h** 2 : 3 : 4 **i** 2 : 5 : 7

8 **a** 6 **b** 35 **c** 24
d 42 **e** 20 **f** 50
g 18 **h** 48 **i** 40

9 **a** 3 : 2 **b** 4 : 3 **c** 8 : 15
d 9 : 14 **e** 3 : 4 **f** 65 : 44
g 20 : 27 **h** 168 : 235 **i** 2 : 5

10 **a** 300c : 40c = 15 : 2
b 50c : 750c = 1 : 15
c 275c : 25c = 11 : 1
d 75c : 425c = 3 : 17
e 180c : 300c = 3 : 5
f 120c : 400c = 3 : 10

11 **a** 6 h : 24 h = 1 : 4
b 26 weeks : 104 weeks = 1 : 4
c 4 weeks : 52 weeks = 1 : 13
d 26 weeks : 156 weeks = 1 : 6
e 20 h : 72 h = 5 : 18
f 0.5 years : 4 years = 1 : 8
g 60 h : 168 h = 5 : 14
h 450 min : 2880 min = 5 : 32

12 **a** 250 mm : 12 mm = 125 : 6
b 2 km : 12 km = 1 : 6
c 200 m : 4000 m = 1 : 20
d 5 mm : 15 mm = 1 : 3
e 2000 m : 400 m = 5 : 1
f 500 cm : 30 cm = 50 : 3
g 2 km : 12 km = 1 : 6
h 2000 m : 12 000 m = 1 : 6

13 **a** 5 mL : 2 L
b 5 mL : 2000 mL
c 1 : 400

14 **a** 1 : 8
b The station donates $1 for every $8 raised by the listeners

15 **a** $\frac{7}{4} : \frac{7}{6}$ **b** 12 **c** 3 : 2

16 7 : 5 : 9

17 30 cod : 45 flake : 12 coral trout = 10 : 15 : 4

18 1000 : 1 : 75

19 364 weeks : 7 weeks = 52 : 1

20 7 : 50

21 2 : 1

22 3 : 2

23 **a** 1 : 3 : 2
b Four people.

Exercise 1C

1 **a** dividing, denominator, same
b multiplied, same, equivalent

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2 **a** $\frac{10}{20}$ **b** $\frac{14}{21}$ **c** $\frac{35}{40}$
d $\frac{20}{35}$ **e** $\frac{64}{88}$ **f** $\frac{15}{36}$
g $\frac{22}{24} = \frac{55}{60}$ **h** $\frac{26}{50} = \frac{130}{250}$ **i** $\frac{6}{21} = \frac{14}{49}$
j $\frac{25}{30} = \frac{100}{120}$ **k** $\frac{35}{60} = \frac{49}{84}$ **l** $\frac{40}{\frac{320}{3}} = \frac{30}{80}$

3 **a** Examples include:
4 : 6, 10 : 15, 20 : 30 etc.
b Examples include:
6 : 10, 15 : 25, 30 : 50 etc.
b Examples include:
22 : 18, 55 : 45, 110 : 90 etc.
c Examples include:
8 : 12 : 16, 20 : 30 : 40, 40 : 60 : 80 etc.

4 **a** 20 **b** 18 **c** 28
d 1 **e** 11 **f** 4
g 25 **h** 14 **i** 40
j 12, 15 **k** 8, 15 **l** 4, 36
m 6, 21 **n** 20, 5 **o** 7, $\frac{35}{3}$

5 **a** When equating the ratios into fractions we see that $\frac{2}{5}$ does not equal $\frac{8}{11}$.
b Answers may vary; e.g.
4 : 10, 6 : 15, 8 : 20 etc.

6 4

7 15 green lights.

8 8

9 5.652 m

10 27

11 12 goals

12 7.5 kg

13 160 mL

14 1920 mL or 1.920 L

Exercise 1D

1 **a** sum, ratio
b one, sum
c fraction of total amount, total amount

2 **a** 6 **b** 8 **c** 20 **d** 15

3 **a** $\frac{3}{10}$ **b** $\frac{7}{10}$

4 **a** $\frac{6}{11}$ **b** $\frac{5}{11}$

5 **a** $\frac{2}{7}$ **b** $\frac{5}{7}$

6 **a** 2 : 5 **b** 1 : 10 **c** 7 : 10

7 **a** \$10 : \$90 **b** \$25 : \$75
c \$30 : \$70 **d** \$28.58 : \$71.43.

8 **a** \$400 : \$800 **b** \$200 : \$1000
c \$500 : \$700 **d** \$840 : \$360

9 **a** \$10 : \$30 **b** \$30 : \$60
c \$60 : \$90 **d** \$80 : \$140
e 12 kg : 20 kg **f** 350 kg : 100 kg
g 20 L : 28 L **h** 96 L : 36 L
i 160 g : 40 g
j 35 lollies : 14 lollies

10 **a** \$50 : \$100 : \$150
b 54 kg : 81 kg : 135 kg
c 8000 L : 24 000 L : 32 000 L
d \$600 000 : \$400 000 : \$250 000
e 90 m : 90 m : 120 m
f 10 chocolates : 40 chocolates : 30 chocolates
g 100 plants : 50 plants : 30 plants
h \$1000 : \$350 : \$150

11 **a** 39
b $\frac{20}{29}$ ewes; $\frac{19}{39}$ lambs
c 2700 ewes and 2565 lambs.

12 **a** 5 : 4 **b** 9
c $\frac{4}{9}$ **d** 40

13 **a** 10
b $\frac{1}{10}$ accident fatal, $\frac{9}{10}$ non-fatal
c 217 fatalities compared to 1953 non-fatalities

14 **a** Ariana **b** 11 **c** $\frac{5}{11}$
d $\frac{2}{11}$ **e** \$25 000 **f** \$10 000
g \$15 000

15 **a** Jarred paid for three tickets and Ryan paid for his own ticket.
b 3 : 1
c Jarred paid \$42 for three tickets

16 Megan receives \$63 740 and Luke receives \$50 992.

17 Brock receives 166.67 g, Jasper receives 333.33 g and Ruth receives 500 g

18 Gretel receives \$120 000, Helga receives \$120 000 and Marie receives \$360 000

19 **a** 5 L of cordial and 45 L of water
b \$7.65

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20 **a** 300 mL
b $12
21 Cost of cement = $225
Cost of sand = $180
Cost of gravel = $360
Total costs = $765
22 1500 g

Exercise 1E

1 **a** drawing, actual
b 1, 100 cm or 1 m
c second
d smaller, multiply
e larger, divide
2 **a** **i** 1 km
ii 3 km
iii 4.4 km
b **i** 1.5 km
ii 10 km
iii 7.5 km
c **i** 200 m
ii 1 km
iii 64 m
d **i** 450 m
ii 68.75 m
iii 562.5 m
3 **a** **i** 5 m
ii 30 mm
iii 20 m
b **i** 60 mm
ii 20 m
iii 70 mm
c **i** 20 cm
ii 10 mm
iii 70 cm
d **i** 6 mm
ii 0.5 mm
iii 75 cm
4 **a** 1 : 2000
b 1 : 200000
c 1 : 30 000 000
d 1 : 1200
e 15 000 : 1
f 1400 : 1
5 40 000 cm
6 **a** 500 cm
b 1 represents the length of the model and 50 represents the length of the actual car. This is because in a scale ratio, the larger object is the larger number.
c 10 cm
7 **a** 9000 cm
b 500
c 18 cm
8 **a** 8000 cm
b 80 m
c 36 000 cm
d 360 m
e 360 m ÷ 3 m = 120, so there are 120 floors in this building.
9 **a** Divide by 40 since the model of the ship represents the ratio of 1 : 40
b 0.75 m
c 75 cm
d Area is 5 cm × 2.5 cm = 12.5 cm^2
10 **a** A caravan is approximately 4 m long at most; and at 1 : 10 000, the model will be 0.4 mm, which is too small. 1 : 50 is more appropriate.
b A city can be a couple of kilometres long and wide. For example, if a city is 5 km long and wide, the model will be 80 m long and wide, which is impractically large. In this case, 1 : 10 000 is more appropriate.
11 **a** 0.328 m
b 328 mm
12 **a** 13 mm
b 2.6 mm
c 33 mm
d 1300 km
e 85 mm
f 3300 km
g 3000 km
13 **a** 1 : 67
b 2.4 m wide by 4 m long
c 9.6 m^2
d Carpet cost = $633.60
14 **a** 737 cm
b 3.5 cm

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c 1 : 211
d 1.5 cm.
e 320 cm

15 Scale = 1:570.
Scale length = 472.1 mm
Scale width = 49.5 mm
Scale height = 7.9 mm

16 1 : 50

17 Ben Dover is 39 mm in the picture, giving a scale of $\frac{1900}{39}$ = 48.7, therefore approximately 1:49. Height of dog in picture is 14 mm, therefore actual height of the dog is 0.686 m.

18 a Answers will vary.
b Answers will vary. Potential factors to consider include but are not limited to fencing, backyard size and neighbours.

Puzzle

The first windscreen wipers were operated by hand.

Chapter checklist

1 5 : 9
2 $\frac{21}{38} : \frac{17}{38}$
3 8 : 11
4 54
5 200 mL
6 4 : 5
7 3 : 5 : 8
8 20 : 21
9 1 : 20
10 5 : 26
11 3 : 200
12 280 kg : 350 kg
13 $80 000 000V
14 1 : 150
15 30 cm wide 42 cm long, 6 cm tall

Chapter review

1 1 : 3
2 1 : 8
3 1 : 8
4 2 : 1 is the ratio of cardio to weights, so 30 min : 15 min
5 a 144
b 180
6 55 m^3
7 7 : 3 = 105 : 45, so we expect that Martha will lose 45 games in the next 3 years.
8 a 1680
b 613 200
9 Grace will have saved $62 400 and Lilly will have saved $46 800.
10 14.4 kg
11 320 m
12 50 cm : 8 m = 50 cm : 800 cm = 1 : 16. The model will be 50 cm long and 18.75 cm tall.

Chapter 2

Pre-test

1 a 120
b 2
c $\frac{1}{3}$ or 0.333333…
d $\frac{1}{4}$ or 0.25
e 8
f $\frac{1}{2}$ or 0.5

2 a $\frac{1}{2}$
b $\frac{3}{1}$ or 3
c $\frac{3}{7}$
d $\frac{15}{7}$
e $\frac{5}{9}$ (can't be simplified)
f $\frac{2}{3}$

3 a $\frac{8}{3}$
b $\frac{7}{9}$
c $\frac{9}{13}$

4 a length or distance
b money
c time
d capacity or amount of liquid
e weight or mass
f temperature

5 a 3.6 L
b 132 000 m
c 4.5 h
d 2007.5 days
e 6500 c
f 14 kg

6 a distance and time (e.g. km and hour)
b capacity and distance (e.g. L and km)
c money and weight (e.g. $ and kg)

Exercise 2A

1 a different, different
b with, without

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c one
d change, change

2 **a** rate **b** rate
c not a rate **d** rate
e not a rate **f** rate
g not a rate **h** rate

3 **a** m/s **b** $/kg
c $/L **d** words/min
e kj/100 g **f** km/h
g $/m^2 **h** runs/over

4 **a** 60 km/h **b** $1.75/kg
c $300/m^2 **d** 2 tries/game
e 22 mL/day **f** 167 rev/s
g 32 customers/h **h** 2857.1 bottles/h
i 55.6 km/h **j** 1.3 jumps/s

5 **a** 400 km/day **b** 8 kg/year
c 10 km/h **d** 2.4 lollies/min
e 0.4 cm/h **f** 1.33 points/min
g 1.5°C/h **h** 7 cm/year

6 **a** 0.46 km/min
b 0.47 km/min
c Archie

7 **a** **i** 8 km/L
ii 0.125 L/km
b **i** 2.08
ii 12.5 L/100 km

8 **a** **i** 4000 g
ii 125 g/person
b **i** 16 000 mL
ii 500 mL/person

9 $0.40/sausage

10 179 cm

11 3000 members/year

12 10 h

13 **a**

Time (in hours)	Cost of hire from Brooke's Boat	Cost of hire from Jessica's Jetty
1	$32	$16
2	$44	$32
3	$56	$48

b 5 h
c **i** Brooke
ii $12

Exercise 2B

1 **a** multiply
b divide
c square
d weeks, months
e weekly, monthly

2 **a** **i** 72 km/h **ii** 43.2 km/h
iii 15.3 km/h **iv** 243 km/h
b **i** 16.7 m/s **ii** 30.6 m/s
iii 22.2 m/s **iv** 1.7 m/s

3 **a** $0.08/mL **b** $0.25/g
c $120/m^2 **d** 1000 cans/h
e 2.5 L/year **f** 125 cm/min
g 125 g/year **h** 7 600 000/month

4 **a** $280/day **b** $2800/fortnight
c $38.89/h **d** $72 800/year
e $728 000/decade **f** $6066.67

5 **a** $412/day
b $4120/fortnight
c $57.22/hour
d $107 120/year
e $1 071 200/decade
f $8 926.67/month

6 **a** $47.5/h
b $1900/week

7 **a** 36 L/h
b 1333.33 h, 55.56 days or 7.94 weeks

8 **a** 382.82 km/h
b 377.76 km/h

9 0.5 mm per km

10 **a** 6000 L/h
b 100 L/min

11 10.67 km/h

12 13.8 cm

13 0.24 km/h, therefore it takes 2.5 hours to move 0.6 km

14 15 cm/year, therefore it will take 4 years

15 109.8 km/h, therefore the 110km/h speed limit

16 worm

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Exercise 2C

1 a direct, decrease, constant
b equivalent, divided, same

2 a $x = 320$ **b** $x = 76.5$
c $x = 4.5$ **d** $x = 120$
e $x = 630$ **f** $x = 22.5$
g $x = 2$ **h** $x = 7$

3 a $x = 1500, y = 15\,000$
b $x = 14, y = 154$
c $x = 25, y = 750$
d $x = 15, y = 75$
e $x = 70, y = 560$
f $x = 18, y = 234$

4 a 1320 L **b** 2640 L

5 a \$1.2/kg **b** \$3

6 a i \$6
ii \$13.5
b 3.5 kg

7 a 25 L/day
b 9125 L/year
c \$94 900/year

8 1372.55 km

9 200 750 L

10 \$22.50

11 \$3000

12 9 houses

13 \$472.50

14 19 students

15 9:14 a.m.

16 7.79 L

17 100 L

18 84 primary : 90 secondary

Exercise 2D

1 a best, equal
b lowest, highest
c lowest, best
d highest, best

2 a \$0.45/100 g or \$0.42/100 g; 1.2 kg is the best value.
b \$0.65/100 g or \$0.61/100 g; 1 kg is the best value.
c \$0.22/100 g or \$0.21/100 g; 500 g is the best value.
d \$1.28/100 g or \$1.29/100 g; 250 g is the best value.

3 a \$1.25/L or \$1.2/L; 1.75 L is the best value.
b \$2.28/100 g or \$2.55/100 g; 250 g is the best value.
c \$3.20/kg or \$3.30/kg; 1.5 kg is the best value.
d \$7.33/GB or \$7.20/GB; plan B is the best value.

4 a \$0.35/box (box of 40, \$0.25/box (box of 320)
b \$0.10 cheaper

5 a The 2 L bottle is the best value.
b Especially for food, it has an expiry date and might go bad before you can consume it all, which will result in wastage.

6 The carton of 24 cans is the best value.

7 The 600 mL bottle is the best value.

8 More expensive by \$1/kg.

9 Yohann has the fastest walking rate.

10 175 g packet is the best value.

11 a Hayden's car is 7.69 L/100 km; Aria's car is 7.75 L/100 km. So Hayden's car is the most economical.
b \$103.61 for Hayden, \$104.42 for Aria

12 a Bethany's car is 8.33 L/100 km; Teri's car is 8.62 L/100 km. So Bethany's car is the most economical.
b Bethany \$225.82, Teri \$233.61

13 a, b 5×2 L and 1×1.25 L soft drink
2×18 pack of party pies
3×24 pack of little sausages
3×600 g packets of corn chips
c Total = \$51.71

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Puzzle

A steamship propeller.

Chapter checklist

1 16 m/s, 12 cans/s and $6/kg
2 km/h
3 7 goals/game
4 4 cm/year
5 1.75 km/h
6 169.2 km/h
7 25 m/s
8 $x = 3$
9 $x = 63$
10 42 min
11 250 g packet is best value.
12 4.8 m of pine timber is best value.
13 Fuelo has the best value petrol.

Chapter review

1 $2.50/mango
2 7.62 L/100 km
3 a 53.6 ml/min
b 0.3 kg/day
b 1.3 m^3/min
4 a 0.2 m^2/min
b 12 m^2/h
c 10.5 h
5 The carton of 30 eggs is best value.
6 The 175 g packet is best value.
7 882
8 a Mike's car is more economical.
b Lynn's cost is $47.18.
9 A box of 20 is $0.18 per biscuit, a box of 36 is $0.16 per biscuit; therefore a box of 36 is better value.
10 Adam is 3m^2/hour and Bob is 32.73m^2/hour, therefore Bob is quicker by 29.73m^2/hour.
11 Originally $6, now $3, therefore save $3
12 Area is 28 m^2, therefore cost is 28 x 62 = $1736
13 24 000 000/1000 x 12.08 = 289 920 babies born this year.
14 a 8.1 x 12.8 = 103.68 L
b 1.57 x 103.68 = $162.78
15 48 m^2/hour, therefore 1380/48 = 28.75 hours

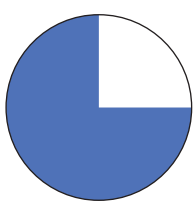
Chapter 3

Pre-test

1 a $\frac{1}{2}$ b $\frac{1}{4}$ c $\frac{1}{10}$
d $\frac{1}{100}$ e $\frac{2}{3}$ f $\frac{3}{100}$
2 a $\frac{1}{5}$ b $\frac{3}{5}$ c $\frac{99}{100}$
d $\frac{16}{25}$ e $\frac{3}{2}$ f $\frac{19}{4}$
3 a $1546 b $2122 c $246
4 a true b true c false
5 a 2 weeks b 52 weeks
c $\frac{2}{7}$ weeks or two-sevenths of a week

Exercise 3A

1 a 100, 100
b per cent, %, 100, fraction
c simplifying, fraction
d division, multiplication
2 a 50% b 10% c 25%
3 a 40% b 10% c 70%
4 ~80%
5



6 a $\frac{1}{10}$ b $\frac{1}{5}$ c $\frac{1}{4}$
d $\frac{2}{5}$ e $\frac{1}{2}$ f $\frac{3}{4}$
g 1 h $\frac{3}{20}$ i $\frac{3}{5}$
j $\frac{6}{25}$ k $\frac{19}{20}$ l $\frac{22}{25}$
7 a 100 b 10 c 2
d 4 e 1 f 3
g 5 h 5, 4 i 3, 2
j 4, 3 k 2, 3

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8 **a** $20 **b** $200 **c** $20
d $421 **e** $70 **f** $600
g $6000 **h** $660
9 **a** 14 kg **b** $47.52
c 74.4 km **d** 47.4 L
e 512 mL **f** $18 750
g 420 kg **h** 338.7 tonnes
10 **a** 920.4 **b** 920 students
11 **a** $5880 **b** $89 880
12 **a** $117 **b** $663
13 **a** 150 g
b 0.67%
c 1 g
d 13.3%
e 20 g
f 9.3%
g 14 g
14 30 marks
15 296 km
16 8400 students
17 $2720
18 **a** $960 **b** $8960
19 IMGood (employs 4195 female employees)

Exercise 3B

1 **a** **1** same **2** fraction
3 100, 100%
b %
2 **a** 50% **b** 25% **c** 30%
d 40% **e** 35% **f** 2.7%
g 17.5%
3 **a** 12.5% **b** 10% **c** 30%
d 12.5% **e** 15.4% **f** 16.5%
g 260% **h** 125%
4 **a** **i** 4000 g **ii** 12.5%
b **i** 3000 mL **ii** 25%
c **i** 8000 m **ii** 15%
d **i** 120 min **ii** 25%
e **i** 1000 c **ii** 4.2%
f **i** 21 days **ii** 23.8%
g **i** 5000 cm **ii** 1.8%
h **i** 3200 mm **ii** 27.5%
i **i** 1800 s **ii** 26.7%
j **i** 168 h **ii** 11.9%
5 **a** 36% **b** 32% for both
6 **a** $\frac{240}{699}$ **b** 34.3% discount
7 75%
8 55.6%
9 34.3%
10 **a** accommodation 45.8%
b airfares 24.2%
c food 30%
11 **a** 2000 m **b** 40%
12 30%
13 22.9%
14 2.5%
15 7.5%
16 3.1%
17 640 g, 32%

Exercise 3C

1 **a** cost
b profit, marking, cost price
c mark-up, percentage
d marked, retail
e decrease, marked
f discounted, subtracted
g GST, 10
2 **a** **i** $120 **ii** $1320
b **i** $60 **ii** $460
c **i** $20 **ii** $180
d **i** $7 **ii** $42
e **i** $700 **ii** $3200
f **i** $87 **ii** $145
g **i** $12 915 **ii** $362 915
h **i** $511.88 **ii** $5761.88
i **i** $164.37 **ii** $363.37

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3 **a** **i** $25 **ii** $100
b **i** $69.50 **ii** $625.50
c **i** $900 **ii** $6600
d **i** $75 **ii** $425
e **i** $60 **ii** $180
f **i** $3.51 **ii** $74.79
g **i** $51.58 **ii** $247.42
h **i** $2563.20 **ii** $26 236.80

4 **a** $5 **b** $28.5 **c** $300
d $5.6 **e** $17.4 **f** $6.99
g $1699.9 **h** $42 650

5 **a** $10.49 **b** $59.46

6 **a** $88.50 **b** $206.50

7 **a** $4.50 **b** $49.50

8 **a** $113.85
b Australia $115.50; NZ cheaper by $1.65

9 $737.50

10 $300

11 $308

12 **a** Triangle Shop
b $1.44

13 **a** Time-off Travel **b** $13.45

14 $8.32 profit

Exercise 3D

1 **a** percentage, change
b don't
c increase, decrease, step, step
d original, percentage, previous
e final amount, original amount

2 **a** $80 **b** $163.97
c $727.82 **d** $24 691.50
e $252 **f** $326 795.25
g $534.08 **h** $220

3 **a** $120 **b** $121
c The second percentage is based on the already increased amount.

4 **a** $0.39 **b** $1.06

5 **a** 92 marks
b improvement of 40 marks

6 **a** $495 000 **b** $598 950
c $583 950

7 **a** $630 **b** $425.25

8 $16.40

9 $15.28

10 9720 L lost

11 ~35.37 tonnes

12 5.69% decrease

Exercise 3E

1 **i** **a** interest, $
b principal, initial
c rate in %
d years
e per annum
ii 4, 12, 26, 52, 365

2 **a** $n = 1.5$ **b** $n = 0.75$
c $n = 1.5$ **d** $n = 2.25$
e $n = 2$ **f** $n = 2.5$

3 **a** $i = 18\%$ **b** $i = 9\%$
c $i = 3.25\%$ **d** $i = 22.75\%$
e $i = 10.4\%$ **f** $i = 36.4\%$

4 **a** $680 **b** $1008
c $2925 **d** $11 970
e $1760 **f** $4290

5 **a** $6804 **c** $1664
b $456

6 $I = \$819\,000$

7 **a** $860.63 **c** $900
b $405

8 $112.80

9 $36 812.50

10 $467.40

11 $480 000

12 $1842

13 $8642

14 **a** $2856 **b** $7.82

15 option 1

16 **a** G3 = F3*6.1%/12, F4 = G3 + F3

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b See spreadsheet

	A	B	C	D	E	F	G
1	**Penny's Term Deposit**						
2		Amount	Interest 6%			Amount	Interest 6.1%
3		20000.00	46.15			20000.00	101.67
4	fortnight 1	20046.15	46.26		Month 1	20101.67	102.18
5	fortnight 2	20092.41	46.37		Month 2	20203.85	102.70
6	fortnight 3	20138.78	46.47		Month 3	20306.55	103.22
7	fortnight 4	20185.26	46.58		Month 4	20409.78	103.75
8	fortnight 5	20231.84	46.69		Month 5	20513.53	104.28
9	fortnight 6	20278.53	46.80		Month 6	20617.80	104.81
10	fortnight 7	20325.32	46.90		Term Deposit Total	20617.80	104.81
11	fortnight 8	20372.23	47.01				
12	fortnight 9	20419.24	47.12				
13	fortnight 10	20466.36	47.23				
14	fortnight 11	20513.59	47.34				
15	fortnight 12	20560.93	47.45				
16	fortnight 13	20608.38	47.56				
17	Term Deposit Total	20608.38	47.56				
18							

c The monthly term deposit is better by $9.42.

Puzzle

Water in a jellyfish.

Chapter checklist

1 $\frac{7}{20}$
2 $540
3 36
4 40%
5 20%
6 25%
7 $405
8 $337.50
9 $59 800
10 $514.91
11 $52 542
12 98c
13 $n = 1.5$
14 13%
15 $285.60

Chapter review

1 93 students
2 $1450
3 90%
4 58%
5 30%
6 12.5%
7 $252 000
8 61.5%
9 $187.20
10 $20.61/kg
11 $9546
12 $810.34
13 $22 560
14 $4536
15 $38 904

Chapter 4

Pre-test

1 **a** 4 **b** 37 **c** 13
d yes **e** 3
2 **a** yes (37) **b** 12 **c** 7
d 35 **e** 6

Exercise 4A

1 **a** words, numbers
b categorical
c numerical

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2 **a** categorical **b** numerical
c categorical **d** categorical
e categorical **f** numerical

3 **a** categorical (words; e.g. bus, walk, car)
b numerical (numbers; e.g. 0, 1, 2…)
c categorical (words; e.g. hip-hop, Country, popular)
d categorical (words; e.g. pizza, burgers, Thai)

4 **a** categorical (words; e.g. speed, fatigue, condition)
b numerical (numbers; e.g. 0, 1, 2)
c numerical (numbers; e.g. 63 km, 108 km)
d categorical (words; e.g. cannabis, meth, amphetamines)
e numerical (numbers; e.g. 0.00, 0.02)
f categorical (words; e.g. positive, negative)

5 **a** categorical (words; e.g. yes or no)
b numerical (numbers; e.g. 0, 1, 2)
c categorical (words; e.g. dog, cat, bird)
d numerical (numbers; e.g. 3.6 kg)
e numerical (numbers; e.g. 5 years)
f categorical (words; e.g. outside, laundry, my bed)
g numerical (numbers; e.g. $12, $30)
h numerical (numbers; e.g. 1 time, 2 times, 3 times)
i numerical (numbers; e.g. 2, 4)
j categorical (words; e.g. black, brown)

6 **a** categorical (words; e.g. yes, no)
b numerical (numbers; e.g. 14 days, 200 days)
c categorical (words; e.g. New Zealand, India)
d categorical (words; e.g. convention, business)
e categorical (words; e.g. New Zealand, India)

7 **a** Answers will vary; e.g. How much are you willing to spend on formal tickets? What time should the formal start?
b Answers will vary; e.g. Where should we hold the formal? Do you want your parents to attend the formal?

8 **a** Answers will vary; e.g. How many hours do you train a week? How much do you spend on sport registration? How many team sports do you participate in?
b Answers will vary; e.g. What sport do you play? What is the highest level you have played at? Have you represented your sport at State level?

Exercise 4B

1 **a** frequency **b** count
c grouped **d** frequency
e checking **f** categorical
g 5 and 10

2 **a**

Snack	Frequency
Packet of chips	8
Muesli bar	16
Hot dog	10
Potato wedges	4
Pizza slice	22

b **i** 4 **ii** 16
c 22
d **i** 22 steps **ii** 11 steps
iii 5 steps
e Count up in 5s; best to have between 5 and 10 steps.

3 **a** 9 **b** 27
c 11 **d** pink
e **i** 14 steps **ii** 7 steps
iii 3 steps
f Count up in 2s

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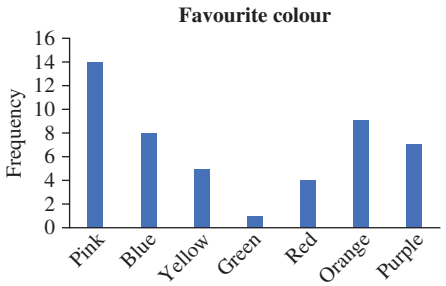
g

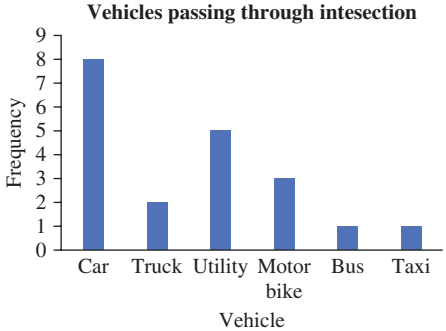


4 a

Category	Tally	Frequency
Car	𝍸 III	8
Truck	II	2
Utility	𝍸	5
Motorbike	III	3
Bus	I	1
Taxi	I	1
Total	**20**	**20**

b car

c

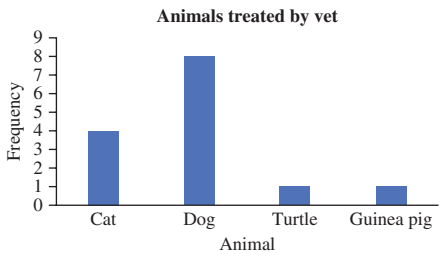


5 a

Animal	Tally	Frequency
Cat	IIII	4
Dog	𝍸 III	8
Turtle	I	1
Guinea pig	I	1
Total	**14**	**14**

b dog

c

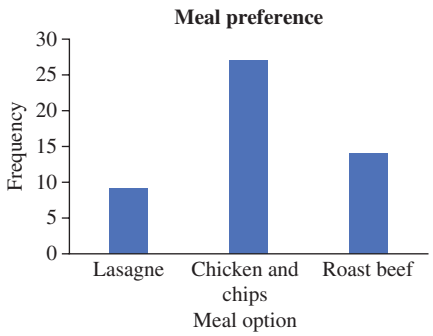


6 a

Meal	Tally	Frequency
Lasagne	𝍸 IIII	9
Chicken and chips	𝍸 𝍸 𝍸 𝍸 𝍸 II	27
Roast beef	𝍸 𝍸 IIII	14
Total	**50**	**50**

b chicken schnitzel and chips

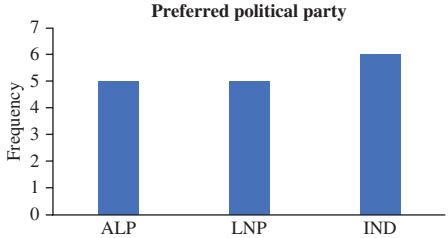
c



7 a

Party	Tally	Frequency
ALP	𝍸	5
LNP	𝍸	5
IND	𝍸 I	6

b



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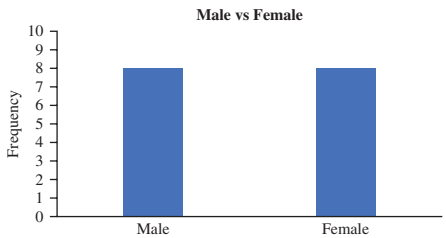
c

Gender	Tally	Frequency
Male	𝍸 III	8
Female	𝍸 III	8

d



8 a

Region	Frequency
Oceania (New Zealand, PNG…)	1 500 000
North-West Europe (UK, France…)	1 400 000
South-East Europe (Italy, Spain…)	200 000
Americas (Canada, USA, Mexico…)	1 100 000
North Africa and the Middle East (Israel, UAE…)	100 000
South-East Asia (Thailand, Indonesia…)	1 400 000
North-East Asia (China, Japan, Korea…)	2 500 000
Southern and Central Asia (India, Pakistan…)	400 000
Sub-Saharan Africa (South Africa…)	100 000
Total	8 700 000

b

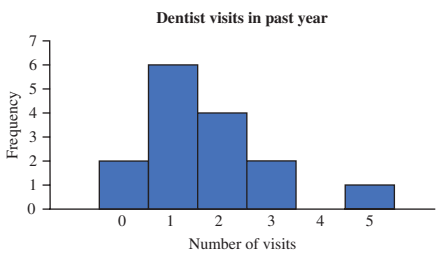
Exercise 4C

1 a column, no
b horizontal
c frequency
d touch
e gap

2 a

Visits	Tally	Frequency
0	II	2
1	𝍸 I	6
2	IIII	4
3	II	2
4		0
5	I	1
Total	15	15

b one visit per year
c count up in 1s
d



3 a 40 students
b 20–25 min
c 2s

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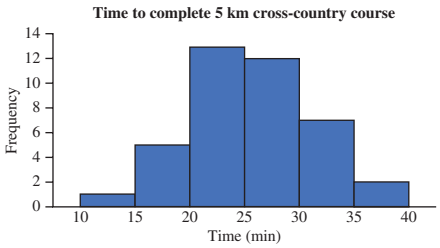
d



4 a 22 h

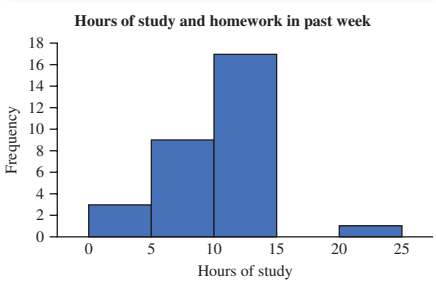
b 1s > 22 steps, 2s > 11 steps, 5s > 5 steps; therefore, 5s is best.

c Groups of 5 and need to start at 0, so 0–4, 5–9, 10–14 etc.

d

Hours	Tally	Frequency
0–4	𝍸	3
5–9	𝍸 |	9
10–14	𝍸 𝍸 𝍸 ||	17
15–19		0
20–24	|	1
Total	30	30

e

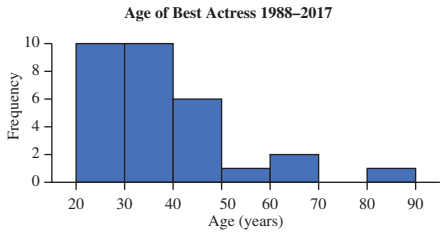


5 a youngest = 22, oldest = 80, group in 10s

b

Age Best Actress	Tally	Frequency
20–29	𝍸 𝍸	10
30–39	𝍸 𝍸	10
40–49	𝍸 |	6
50–59	|	1
60–69	||	2
70–79		0
80–89	|	1
Total	30	30

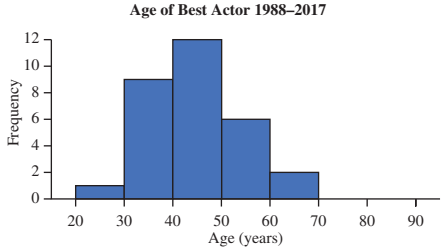
c



d

Age Best Actor	Tally	Frequency
20–29	|	1
30–39	𝍸 ||||	9
40–49	𝍸 𝍸 ||	12
50–59	𝍸 |	6
60–69	||	2
70–79		0
80–89		0
Total	30	30

e



f The range is similar, with most ages between 20 and 70 years.

g Differences include highest frequency for Best Actress is between 20 and 40 years. Highest frequency for Best Actor is 40–50 years. Best Actor has a frequency of only 1 in 20–30 years.

6 a No gap; would expect a close range of ages from 15 to 17 years.

b Yes. Although the students' ages would not produce a gap, the teachers would have a greater range and likely some gaps between the ages of the older teachers.

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c Yes, you would expect a wide range of ages amongst a random group of people.

d Yes, you would expect a wide range of ages amongst a random group of people.

7 a false

b true

c false

d true

e true

Exercise 4D

1 a plots, distribution

b data, range, dot

c leaf, order

d stem, leaf

2 **A** and **iii**, **B** and **iv**, **C** and **ii**, **D** and **i**

3 a 10 students

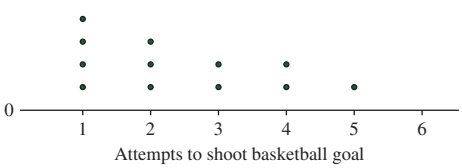
b 5, 7.5, 9, 15, 15, 20, 20, 20, 25, 45

c 20 min

d 45 min

e 5 min

4

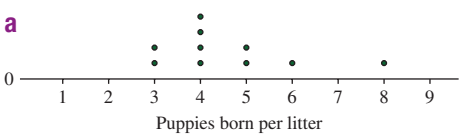


5 a 18 students

b 13 students

c 4 cm

6 a



b Most common litter size is four puppies.

c Eight puppies in one litter is unusual.

7 a lowest = 61, highest = 151

b Use 6 to 15 for the stem.

c **Student Heart Rates after doing 1 minute of jumping jacks**

Stem	Leaf
6	1
7	
8	4 6 8
9	2 9 9 9
10	
11	3 4
12	1 2 4 4 7 9
13	8
14	4 7 8
15	1

Key: 6 | 1 = 61

8 a

Stem	Leaf
1	3 5 5 8 9
2	0 0 3 6 8
3	4 6

b 36°C

c 13°C

9 a

Stem	Leaf
2	2 5 6 6 6 8 8 9 9 9
3	0 2 3 3 3 4 5 5 6 9
4	1 2 4 5 5 9
5	4
6	1 2
7	
8	0

b

Stem	Leaf
2	9
3	2 2 3 6 7 7 8 8 9
4	0 1 1 2 3 3 4 5 5 6 7 8
5	0 0 1 2 4 5
6	0 0
7	
8	

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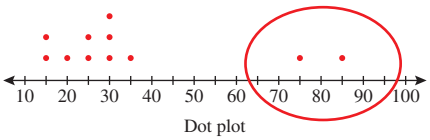
c The Best Actress ages are younger than those for the Best Actors. For Best Actress, the most common ages are 20–30 years and 30–40 years, with 10 in each group. The most common age group for Best Actor is 40–50 years, with 12 actors in their 40s receiving a Best Actor award over the period studied.

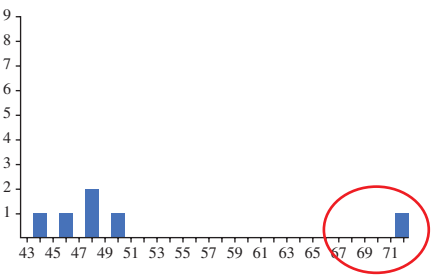
Exercise 4E

1 outlier, long, above, below

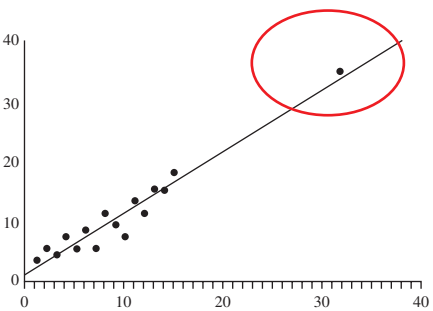
2 a



b

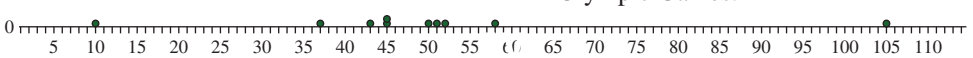


c



3 a 10, 37, 43, 45, 45, 50, 51, 52, 58, 105

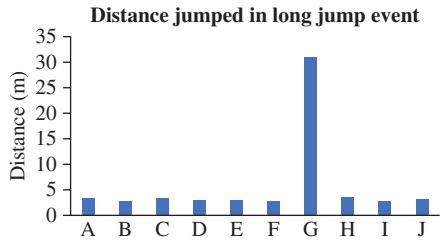
b



c 10 and 105 are outliers.

d 10; perhaps the last day is on a weekend and the business has reduced working hours.
105; perhaps the business ran a promotion and lots of people signed up.

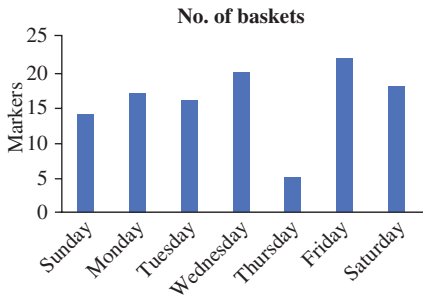
4 a



b student G (31 m is an outlier.)

c 31 m is likely to be a mistake and should be 3.1 m.

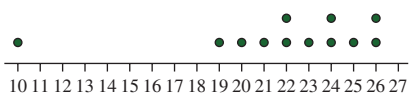
5 a



b Thursday, with only five baskets picked, is an outlier.

c The worker may not have worked a full day for whatever reason (e.g. rain, heat, illness etc.)

6 a



b 10 is an outlier.

7 a United States result of 121 medals is an outlier.

b Outlier(s) for Gold: USA, Silver: USA, Bronze: Canada and United States.

c The size and wealth of the United States increases its performance at the Olympic Games.

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8 a Outliers: 416 mm and 413 mm; 2013 (416 mm) and 2011(413 mm) are a long way above the rest of the data and are outliers. The 2004 reading of 198.7 mm could also be considered unusual enough to be an outlier

b No outliers; Although there are some high readings in the 200s, there are enough of them to not be considered different enough to be outliers.

c Outlier: 313.6 mm; The 2017 reading (313.6 mm) is a lot different from the rest of the data.

d No outliers; All data is low and close together; no outliers.

e Outlier: 134.2 mm; The 2015 reading (134.2 mm) is a lot different from the rest of the data.

f Outliers: 105 mm, 77.8 mm, 72.6 mm; July looks to be a traditionally dry month with the mean being only 28 mm. The 1998 reading (105 mm) is very different. You could also consider the 1999 (77.8 mm) and 2008 (72.6 mm) readings to be outliers.

g No outliers; All data is low and close together; no outliers.

h Outliers: 74.2 mm, 119 mm, 92.6 mm, 104 mm; September looks to be a traditionally dry month with lots of data below 25 mm. The mean is 36.5 mm. The rainfall in 1997, 1998, 2010 and 2016 are all above 70 mm, so would be considered unusual and outliers.

i No outliers; the data is quite spread out.

j Outlier: 165.2 mm; The 2001 reading of 165.2 mm is a lot different from the rest of the data.

Exercise 4F

1 a information, equal

b trends, between

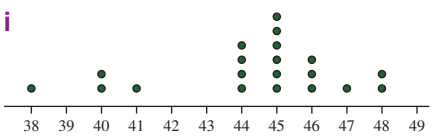
c simple, message

d careful, lose, features

2 a

Age of mother	Tally	Frequency
38	I	1
39		0
40	II	2
41	I	1
42		0
43		0
44	IIII	4
45	IIII I	6
46	III	3
47	I	1
48	II	2
Total	20	20

b i

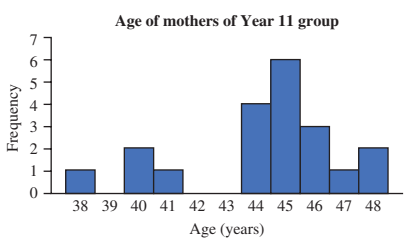


Age of mothers (in years) of Year 11 group

ii

Stem	Leaf
3	8
4	0 0 1 4 4 4 4 5 5 5 5 5 5 6 6 6 7 8 8

iii



c The dot plot and histogram give a quick overview of the data distribution and are visually appealing. The stem-and-leaf plot is not suitable as the range is too small.

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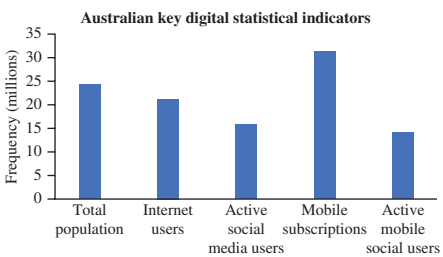
3 a The data is presented in the form of a table but without showing the table outline.

b Yes, there are more mobile subscriptions than people, so 128% indicates this. Many business people would have a separate phone for personal and business calls.

c

Category	Frequency (millions)
Total population	24.48
Internet users	21.18
Active social media users	16
Mobile subscriptions	31.35
Active mobile social Users	14

d



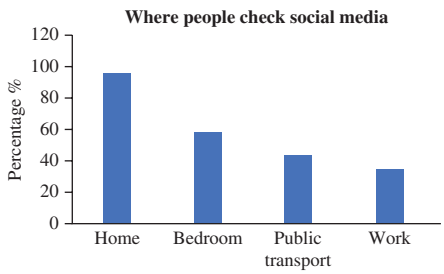
e The column graph gives a good visual comparison of the adoption of digital technology, especially with respect to the population presented in the first column.

4 a The data is presented in a table form with graphics added.

b

Category	Frequency (%)
Home	96
Bedroom	59
Public transport	43
Work	35

c



d The information does not work well as a dot plot because it is categorical data.

e A column graph is the most suitable method to present the information, as you can visually compare the values to each other. Graphics could be added for visual appeal.

5 a The data has been presented in a histogram graph.

b

Age	Frequency (estimated)
15–19	40
20–24	40
25–29	100
30–34	300
35–39	550
40–44	1000
45–49	1800
50–54	2100
55–59	2050
60–64	2350
65–69	2500
70–74	1700
75–79	1300
80–84	850
85+	980

c No, grouped data does not work well as a dot plot.

d Since the data shows the frequency of grouped numerical data, a histogram

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is the most appropriate method and should be drawn *without* spaces between the columns.

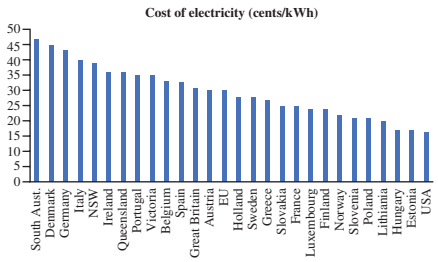
6 a The data is presented as a bar graph. (Note — a horizontal column graph is called a bar graph)

b

Region	Cost of electricity (cents/kWh)
South Aust.	47
Denmark	45
Germany	43
Italy	40
NSW	39
Ireland	36
Queensland	36
Portugal	35
Victoria	35
Belgium	33
Spain	33
Great Britain	31
Austria	30
EU	30
Holland	28
Sweden	28
Greece	27
Slovakia	25
France	25
Luxembourg	24
Finland	24
Norway	22
Slovenia	21
Poland	21
Lithiania	20
Hungary	17
Estonia	17
USA	16

c The data could not be drawn as a dot plot as it is categorical data.

d



e The newspaper graph does not show a scale and has exaggerated the difference between expensive and cheaper regions.

f The newspaper method is suitable but is misleading in the difference between what regions pay for electricity.

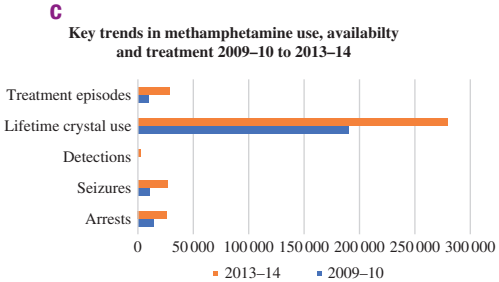
g A column graph is a suitable method but it should be drawn to a scale so as to not be misleading.

h The newspaper appears to be saying the electricity providers are making a profit because their share prices have been increasing.

7 a The information has been presented in a table, with multiple columns indicating the frequency for two different time periods.

b Using a table means that the numbers are easily read rather than have to be estimated on a graph.

c



d Since the data is categorical, either a table or column graph is the most suitable method to present the data.

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e The table is more suitable because the data has a large range of values. Including the data on lifetime crystal use makes the other categories seem to have little significance on the column graph, when they absolutely do.

8 a column graph

b A comparison can easily be made between usage of desktop and mobile phone for accessing the internet.

c

Country	Desktop	Mobile
USA	2100	5500
Canada	2300	3900
France	1800	4000
Germany	1700	3300
Italy	1750	2800
Spain	1800	4600
UK	1800	4600
Argentina	1800	6500
Brazil	1800	4500
Mexico	1500	3900
India	1500	2900
Indonesia	1500	4000
Malaysia	1500	3800

d No, it could not be shown as a dot plot as it compares two different pieces of information.

e The column graph is the best way to display the information, as it is easy to see differences in the data.

9 a column graph

b The differences are easy to see. The use of colour makes it easy to identify different countries.

c

Country	Smartphone	Tablet	Laptop	Desktop
UK	75	52	66	39
France	77	45	71	50
Germany	78	43	72	51
Italy	85	51	68	51
USA	69	45	61	47
Japan	58	25	66	38
Australia	77	46	67	49
Spain	87	55	73	56
Sweden	78	44	69	41

d The information could also be presented in a table.

e The column graph is a suitable way to display the data. It is attractive with the use of colour and trends can be seen easily. The data for each country does not add to 100% so a pie chart would not be suitable.

10 a bar chart

b The main search reasons are shown at the top with lower values shown below it. The percentages on the bar emphasise the importance of Food & Beverage searches on mobile devices above other reasons like banking.

c A picture graph would add interest and explain the categories. A table also would be useful to display the information.

d The bar chart is a suitable method and shows the information well.

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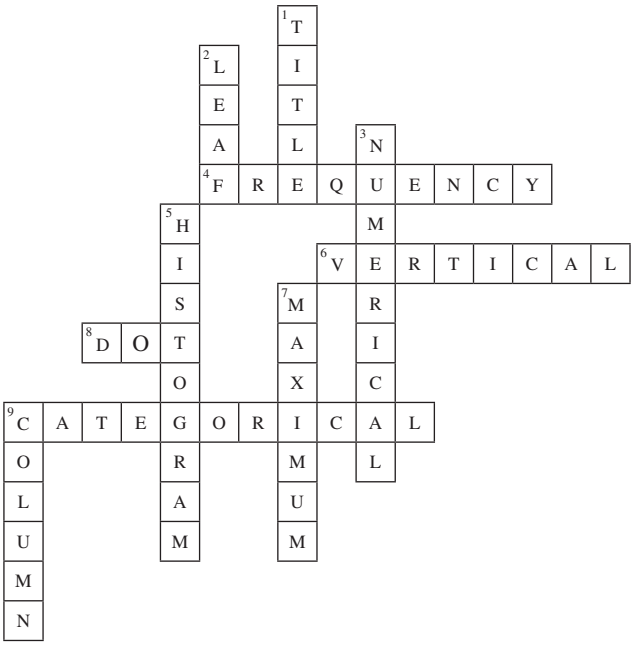
Puzzle



Chapter checklist

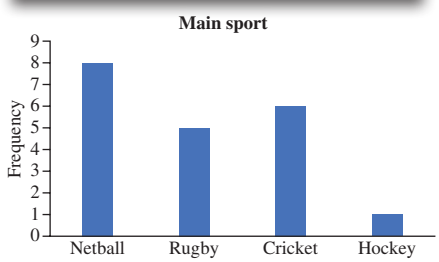
1 a numerical

b categorical

2 a

Sport	Tally	Frequency
Netball	𝍸 III	8
Rugby league	𝍸	5
Cricket	𝍸 I	6
Hockey	I	1
Total	20	20

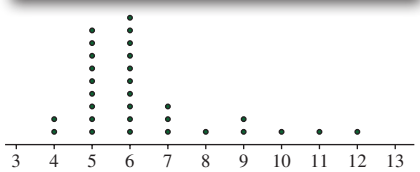
b



3 a

Hours of study	Tally	Frequency
4	II	2
5	𝍸 IIII	9
6	𝍸 𝍸	10
7	III	3
8	I	1
9	II	2
10	I	1
11	I	1
12	I	1
Total	30	30

b



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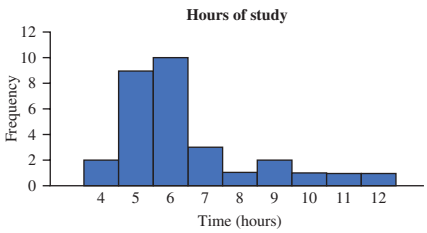
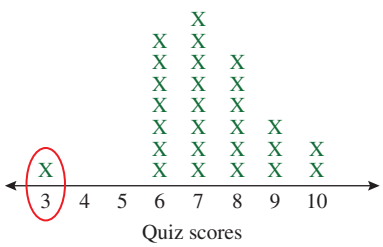
c

Stem	Leaf
0	4 4 5 5 5 5 5 5 5 5 5 6 6 6 6 6 6 6 6 6 7 7 7 8 9 9
1	0 1 2

d



4



5 a i dot plot: yes

ii stem plot: yes

iii column graph: yes

iv histogram: yes

b i dot plot: Yes but it would be difficult to make sense of large frequencies.

ii stem plot: Yes but all data would be on the same line.

iii column graph: Yes, this would work well but numbers would be better presented as a histogram with no gaps between columns.

iv histogram: Yes, this would work very well.

c histogram

Chapter review

1 a numerical (0, 1, 2 etc.)

b categorical (dog, cat)

c categorical (AMP, BHP, NAB)

d numerical (1500, 3000)

e numerical (132.6, 156.8)

f categorical (unleaded, diesel, gas, electricity)

2 a Answers will vary. Examples: How often do you have lunch from the canteen? How much do you spend on lunch? On a scale of 1 to 5 how would you rate the canteen food?

b Answers will vary. Examples: What days do you have lunch at the canteen? Do you think the food is good at the canteen?

3 a

Maths	Frequency
Essential	6
General	9
Methods	7
Methods + Specialist	3

b General

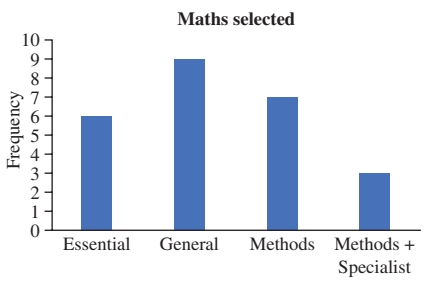
c i nine steps

ii five steps

iii two steps

d either 2s or 1s

e



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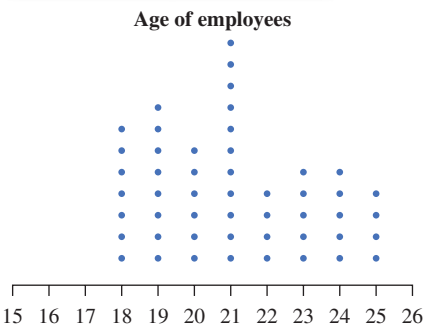
4 a

Age (years)	Frequency
18	7
19	8
20	6
21	11
22	4
23	5
24	5
25	4
Total	50

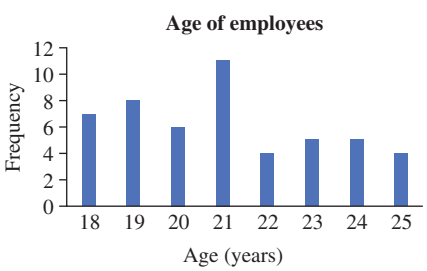
b



c

Stem	Leaf
1	8 8 8 8 8 8 8 9 9 9 9 9 9 9 9
2	0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 2 2
	2 2 3 3 3 3 3 3 3 4 4 4 4 4 4 5 5 5 5

d



e A histogram is the easiest graph to interpret.

5 a 4; perhaps an entry error

b 3, 115, 126; unknown reason

c 14; some of the raisins have been eaten from that box.

d −85; perhaps an entry error.

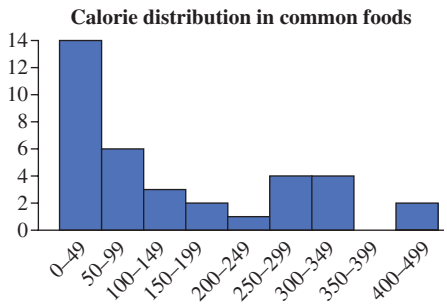
6 a numerical data

b lowest = 8(cucumber), highest = 420 (pork)

c Counting up in 50s takes nine steps.

Calories	Frequency
0–49	14
50–99	6
100–149	3
150–199	2
200–249	1
250–299	4
300–349	4
350–399	0
400–449	2
Total	36

d



7 a categorical

b

Major nutrient	Frequency
Magnesium	1
Niacin	5
Potassium	5
Vitamin A	5
Vitamin Bl	2
Vitamin B6	2
Vitamin B12	6
Vitamin C	9
Vitamin K	1
Total	36

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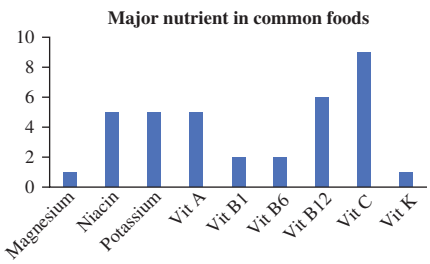
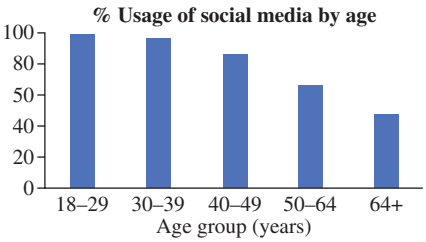
c



8 **a** info graphic

b Visually appealing and retains information

c



d No, dot plots are for numerical data that is not grouped.

e A column graph is most appropriate. Although we have numerical data, the groups are not the same size, so a histogram is not appropriate.

9 A and iii, B and i, C and v, D and ii, E and iv

10 A and ii, B and iii, C and i

Chapter 5

Pre-test

1 **a** 4 **b** 3 **c** walk

2 **a** 17 **b** Toyota **c** 9

3 **a** 6 **b** 21

c 4 **d** 9

4

	Class A	Class B	Total
Boys	12	16	28
Girls	13	10	23
Total	25	26	51

Exercise 5A

1 **a** horizontal **b** line

c included **d** excluded

e categories **f** bar

2 **a** **i** \$20 **ii** \$40 **iii** \$30

b If there is no initial charge, then people could hire the trimmer for less than 1 hour and presumably receive free hire of the service.

3 **a** 8 **b** 5

c dog **d** guinea pig

4 **a** \$6 **b** 200 g

5 **a** April 2017 to July 2017

b 2100 kWh

c Fran and Cindy have air conditioning installed, resulting in more power being used in the warmer months.

6 **a** \$15 **b** \$30 **c** \$35

d 60 GB (included) to 75 GB (excluded)

e 90 GB (included) to 120 GB (excluded)

f \$25

7 **a** Number of commencements

b January

c This is the beginning of the year during which school/university holidays have just ended; Students researching degrees or study courses.

d 2000 students

8 **a** 20%

b 7.5%

c South Australia

d Northern Territory

e Yes; South Australia has the highest proportion of households that use solar electricity.

9 **a** 17.4% **b** 24.2%

c Informal care decreased from 28.4% in 2011 to 24.2% in 2014 to 22.2% in 2017.

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Exercise 5B

1 **a** sectors
b percentage
c symbols, icons or pictures
d key/legend
e information visually

2 **a** fire **b** 44% **c** $750 000

3 **a** Mari **b** 25 **c** 26%
d drawing two-fifths of a car
e Bar graph would probably be better. The current graph measures sales only over 5 cars sold per person; this measurement is too inaccurate.

4 **a** 90 students **b** 27.59%

5 **a** Advantages of a pie graph:
- displays relative proportions of multiple classes of data
- size of the circle can be made proportional to the total quantity it represents
- summarises a large dataset in visual form
- can be visually simpler than other types of graphs
- permits a visual check of the reasonableness or accuracy of calculations
- requires minimal additional explanation
- can be easily understood due to widespread use in business and the media.

b Disadvantages of a pie graph:
- does not easily reveal exact values
- many pie charts may be needed to show changes over time
- fails to reveal key assumptions, causes, effects or patterns
- can be easily manipulated to yield false impressions.

c Values of the exact percentages have not been shown.

6 **a** 15 **b** 6
c none **d** customer service
e tutor **f** 65
g 33 **h** 97

7 **a** 9 **b** 7
c disagree **d** 8
e 26 **f** 44
g 6

8 **a** **i** Eastern Asia, South-Eastern Asia, Sub-Saharan Africa, Southern Asia
ii Eastern Asia decreased 134 365 000 people; South-Eastern Asia decreased 74 445 000 people; Sub-Saharan increased 38 535 000 people; Southern Asia decreased 16 205 000
b The world hunger problem is improving since the number of people who are affected by world hunger has decreased.

Exercise 5C

1 **a** variables **b** straight
c horizontal **d** convert

2 **a** Year
b Unemployment rate (as a %)
c

Year	Unemployment rate (%)
1	3.2
2	6
3	6.8
4	7
5	5.2
6	5.4
7	5.6
8	6.8
9	7.2
10	7.6

d Unemployment rate has increased overall.

3 **a** $15 **b** $60
c $40 **d** $100

4 **a** $120 **b** 38 m^2 **c** $170
d Various answers possible, such as conversion rate between currency, converting between values of trade etc.

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5 **a** 76 **b** 140
c 146 **d** 30
e Sandra started to sprint or had to run uphill
f 17
g Sandra stopped for a rest or slowed down to a walk

6 **a** **i** 6 miles
ii 37 miles
iii 26 miles
iv 61 miles
b **i** 16 km
ii 48 km
iii 55 km
iv 68 km

7 **a** 6000 kWh
b 5700 kWh
c 6250 kWh
d February
e This would be possibly the hottest month, so the family would possibly be using air conditioning more.
f 300 kWh

8 **a** 212°F **b** 32°F **c** 38°C

Exercise 5D

1 **a**

	A	B	Total
C	8	5	13
D	2	7	9
Total	10	12	22

b

	A	B	Total
C	13	48	61
D	32	25	57
Total	45	73	118

2 **a**

	A	B	Total
C	4	7	11
D	9	6	15
Total	13	13	26

b

	A	B	Total
C	17	24	41
D	20	5	25
Total	37	29	66

3 **a** 16 **b** 21
c 9 **d** 13
e 6 **f** 2

4 **a** 82 **b** 67
c 24 **d** 6.1%

5 **a** 200 **b** female
c sports car **d** 20
e 9.4%

6 **a** 7.29% **b** 87.5%
c 6.25% **d** 11.46%

7 **a** 15.43% **b** 13.53%
c 23.35% **d** 68.03%

Exercise 5E

1 **a** misleading **b** biased
c broken **d** size

2 **a** Graph 1 is misleading as the scale is broken.
Graph 2 is not misleading as the scale is not broken.
b Graph 1 is not misleading as the scale is not broken.
Graph 2 is misleading as the scale is broken.

3 **a** no
b That company sales have maintained the same level over the years 2014 to 2017.

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c The angle at which the graph has been presented makes it difficult to determine how the sales have changed. It gives the impression that the number of sales has remained constant, whereas they could have been decreasing.

4 a That the unemployment problem has been solved.

b The title is biased, telling the reader what to think, and the scale is broken, making a small change look much bigger. Also, there is no data before Feb 2017; earlier data could show a different trend from the more recent data presented here.

5 a No, the trends appear to be different.

b Graph A, as there is a greater range of data.

c Its misleading because the scale of the graph is too small, making it difficult to see any changes.

d It will definitely be used as it will mislead the parents into believing that the enrolment numbers have been quite consistent throughout the years.

6 a That soccer is more popular than rugby league.

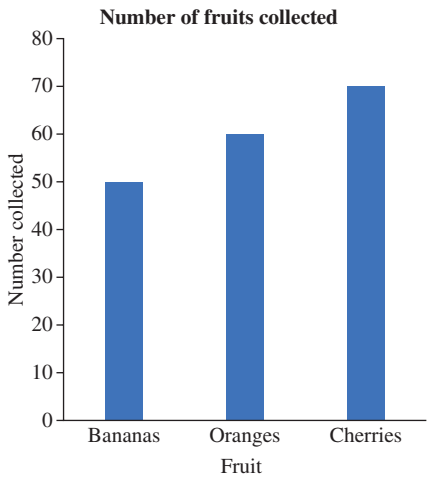
b The columns are not the same width. This makes the column for soccer look much bigger than that for rugby league when, in fact, its height is less.

c John is biased towards soccer, trying to convince his friend that it is more popular than rugby league.

7 a 50 bananas, 60 oranges and 70 cherries were collected.

b The graph is misleading as it makes it appear there are more bananas because the bananas occupy the most area and are furthest to the right, whereas there are more cherries.

c



8 a Walking is the most popular method of getting to school.

b The icons used to represent one student are not the same height. So the height of the walk column is much taller than the others when, in fact, bus is the most popular response.

9 a The larger the business, then the more likely that the business has a social media presence.

b Larger businesses have social media. Therefore, growing and successful businesses succeed by utilising social media.

c By categorising the business types without revealing the number of businesses that fall into each category, could deem the data to be inaccurate.

Exercise 5F

Fundamentals

1 a 38.5%

b 78.13%

c 57.89%

d 50%

e The table shows there are differences in each position of the police force with regard to males and females.

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Males have a greater percentage in the constable (60.1%) and sergeant (78.1%) roles. In the inspector role, females dominate (57.9%). However, in the role of chief inspector there are an equal number of males and females. With males having a greater percentage in two out of the four roles, as well as being equal in one role, it would be acceptable to state that males dominate in this particular study.

2 a health

b China 20%; Australia 30%

c The pie charts show the proportion of money spent on various household expenses in China and Australia in 2017. We can see that, in Australia, the greatest proportion of expenditure (30%) is on food, whereas in China food accounts for just 20% of the total. In contrast, the greatest single expense in China is recreation (31%) compared with 25% in Australia. Food and transport come in equal second place in China (20%), whereas in Australia housing and recreation come in equal second place (25%). In China, another major expense is transport (20%), but this is much lower in Australia (10%). In both countries the smallest percentage of expenditure is on health care. Overall, the data indicates that, in both countries, food, housing and recreation are the main expenses, and that in China transport and recreation take up a higher proportion of total expenditure than in Australia.

3 a 5 min

b i 15 min

ii 30 min

iii 19 min

c pH 5

d Answers may vary. All of the sweet substances have the possibility of causing tooth decay. However, sugar derived from honey and fruit are likely to cause less decay than cane sugar.

4 a The graph shows the ups and downs of the Australian share market since 1900. The graph's overall trend is it's distinctly heading in one direction – up.

b ending of World War I, The Great Depression, decimal currency introduced, OPEC oil embargo begins

c Check with your teacher.

d Check with your teacher.

5 a satisfied 72.4%; dissatisfied (overweight) 22.4%; dissatisfied (underweight) 5.3%

b satisfied 65.2%; dissatisfied (overweight) 17.4%; dissatisfied (underweight) 17.4%

c The data shows that 65.2% of male survey participants are satisfied with their body weight, and 72.4% of female participants are satisfied. Of those females who are not happy with their body image, there is a higher percentage who consider themselves overweight. Of those males who are not happy with their body image, the percentage is equal for over and underweight. This information shows that there is a higher percentage of participants who are satisfied than dissatisfied for both males and females, therefore the data suggests that these body image categories are not related to gender.

6 a Highest to lowest internet penetration: North America (77.4%), Oceania/Australia (61.3%), Europe (58.4%), Latin America/Caribbean (34.5%), Middle East (29.8%), Asia (21.5%), Africa (10.9%).

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b Highest to lowest growth percentage of internet users: Africa (2357.3%), Middle East (1825.3%), Latin America/Caribbean (1032.8%), Asia (621.8%), Europe (352%), Oceania/Australia (179%), North America (146.3%).

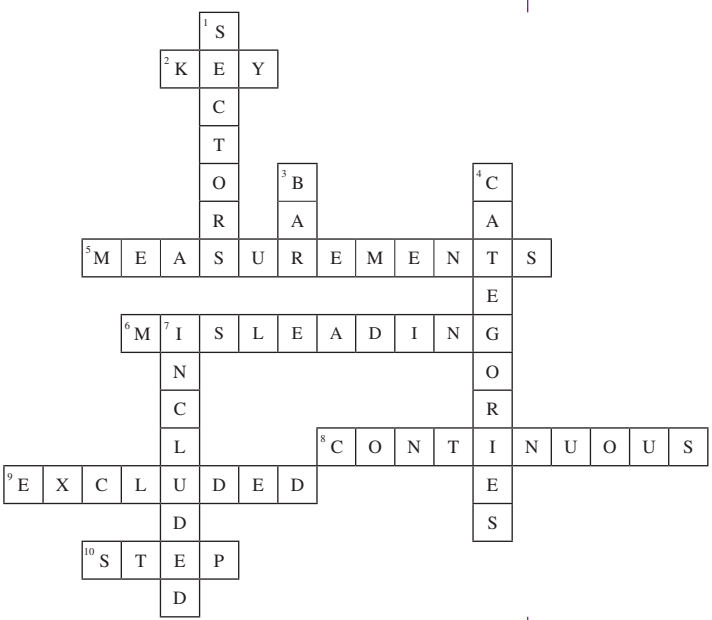
c Founded on the given statistics, it can be noted that the regions with the lowest existing percentage of internet penetration are also the regions in which internet penetration is growing at the quickest rates. The internet penetration in Asia is not growing nearly as fast as it is in Africa, the Middle East and Latin America.

7 a 40%

b 25%

c Answers will vary. Australia ranks lowest among OECD countries for the relative income of people with disabilities, at 27th. Overall employment rates for people with disabilities remain low, with workforce participation at around 54% compared to 83% for people without disabilities. 1.2 million people with disabilities report difficulties using public transport.

Puzzle



Chapter checklist

1 $4

2 25 min

3 12%

4 six magpies

5 22°C

6 1190 Cal

7 20

8 This graph has been altered, as the right-hand column should be narrower. Also, the scale has been manipulated and the baselines omitted to create a larger gap in the data than is really there. The graph does not start at zero and the columns are different widths.

9 female

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Chapter review

1 **a** 5 **b** 8
c Tuesday, Thursday and Friday of the first week, and Wednesday of the second week
d Janet worked the same number or more hours than Dan.

2 **a** 58 mm
b 34 mm
c February
d November to April, as these are the six months with the highest levels of rainfall.

3 **a** 8 a.m. **b** 1 p.m.
c 14 (inclusive) to 16 (exclusive)

4 **a** 65.6% **b** 14.5%
c 19.9% **d** 86.0%

5 **a** 6% **b** 15%
c 75–84 years
d Males more likely to have diabetes for almost all the age groups, as graph shows males have a higher proportion of having diabetes.

6 **a** 9 **b** 6
c 80% **d** 47.5%

7 **a** In Week 8 the politician had a big drop in popularity rating.
b The scale is broken, making a small drop seem much bigger.
c The producer of this graph possibly would like readers to think that the politician has done something bad to receive a big drop in popularity.

8 **a** **i** Petrol prices have increased steadily over half a year.
ii The horizontal axis is extremely skewed in time; that is, the leap from last year to last week is too big in actual time to be represented by the same length as from last week to today. Shortening the time axis in this way eliminates many of the petrol price fluctuations that have occurred, which could change the message of the graph completely.
iii The horizontal axis needs to be more consistent in scale, such as months. The price per litre on the horizontal axis should be labelled and also increased in its range; e.g. $1.00 to $2.50.
b **i** The population of hawks has made a strong comeback since 1975.
ii The number of birds is misleading, whereby do the values along the vertical axis represent the overall percentage of hawks compared to the number of hawks in the local area or does it represent a multiple of birds?
iii Change the measurement of the vertical axis to better units; e.g. hundreds or thousands.

9 **a** The graph is comparing the number of short-term visitors to Australia in 2015 and 2016.
b December 2016
c May 2015

10 **a** The growth rate of plants were measured according to the amount of sunlight they received.
b No because between the fourth and sixth day the fastest growth rate recorded was for the plant that received 9 h of sunlight.
c 9 h a day
d Adding a title for the graph and having more plants being recorded would be suggested improvements but, otherwise, the graph is pretty good.

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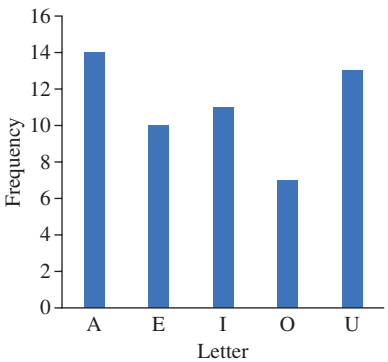
Chapter 6

Pre-test

1 **a** line graph
b pie graph
c histogram
d stem-and-leaf diagram

2 **a** 14 **b** 7

c



3

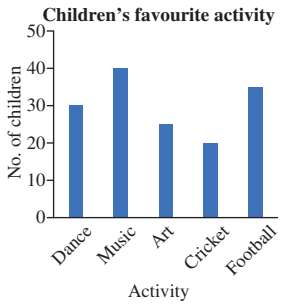
State	Frequency
NSW	5
Qld	17
Vic.	6
SA	5
WA	5
NT	2
ACT	1
Tas.	1

4 **a** 170 kg **b** 230 kg **c** 280 kg

Exercise 6A

1 **a** column graph
b Olivia should use the column graph as it can display relative numbers in multiple categories.

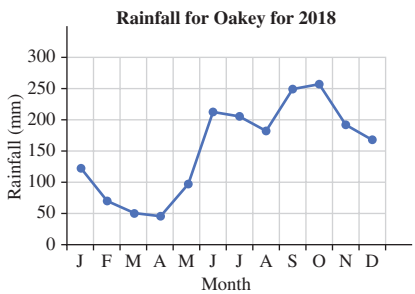
c



2 **a** line graph
b pie graph or column graph

3 **a** line graph
b To better compare the change in rainfall throughout the year

c



4 **a** Stem-and-leaf plot
b Stem-and-leaf plot will suit this type of data, showing all counts neatly. Its presentation works well in this case because the sample size is low and allows Jeff to easily compare the number of snakes in each zoo.

c

Stem	Leaf
1	
2	0 6 8 8
3	0 2 6 6 7 8 8
4	1 2 6 6

5 **a** Line graph
b This allows Brandon to better measure average travel time.

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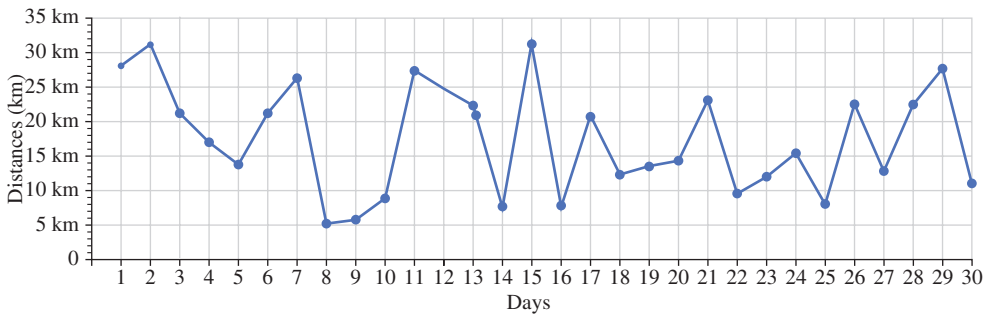
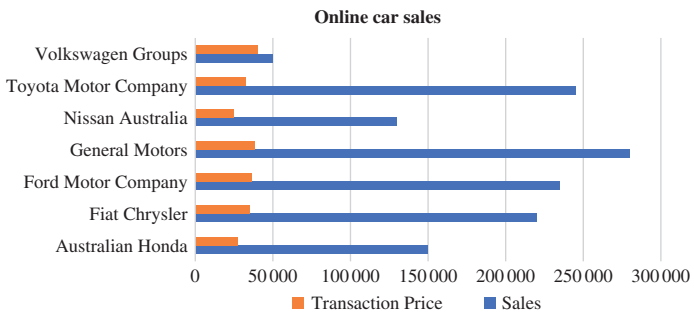
c



6 a bar graph

b Bar graphs help summarise the large data in a visual form, while displaying the relative number in multiple categories.

c



7 a Answers may vary. Many graphs suitable for presenting small samples; e.g. dot plots, bar graphs.

b Displaying small samples and counting a relative number of observations can be done easily with a bar graph or a dot plot.

c Check with your teacher.

8 a two-way table

b Two-way table will allow the respective number of people in their respective categories to be displayed.

c

	Aiming for a HSC	Aiming for TAFE	Apprenticeship	Total
Male	16	46	3	65
Female	12	51	3	66
Total	28	97	6	131

9 a line graph

b A line graph allows better analysis of change over a period of time.

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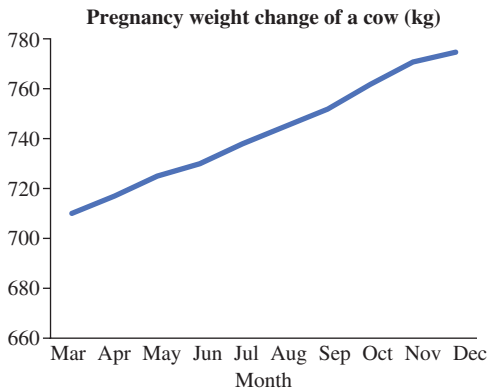
c



Exercise 6B

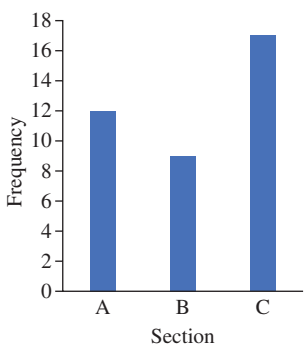
1 a

Colour	Frequency
red	5
green	7
blue	3

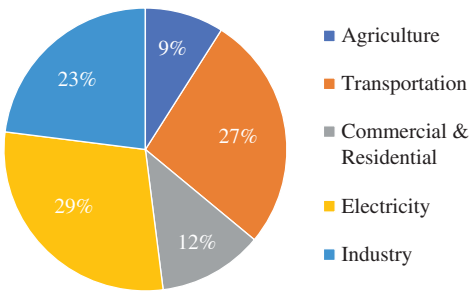
b

Response	Frequency
strongly agree	3
agree	6
neutral	2
disagree	3
strongly disagree	2

2



3



4 a table

b To allocate relative number of meals with multiple categories

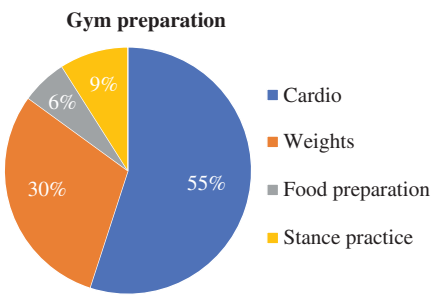
c

Meal	Frequency
chicken	7
beef	4
vegetarian	5

5 a pie chart

b The pie chart can easily show the cycle of an individual's daily life, where the proportion of activities is shown visually.

c



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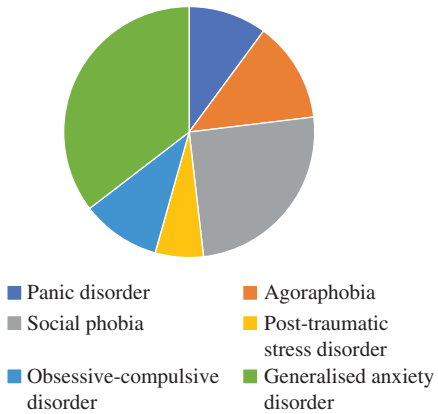
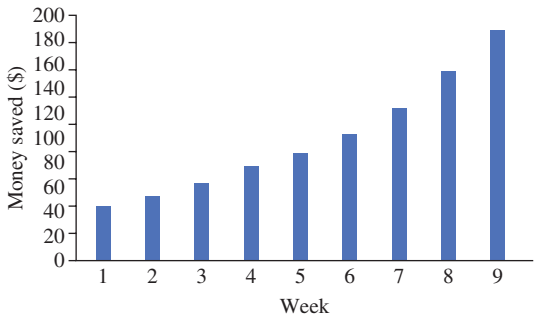
6 a



b Generalised anxiety disorder is the most common.

7 a

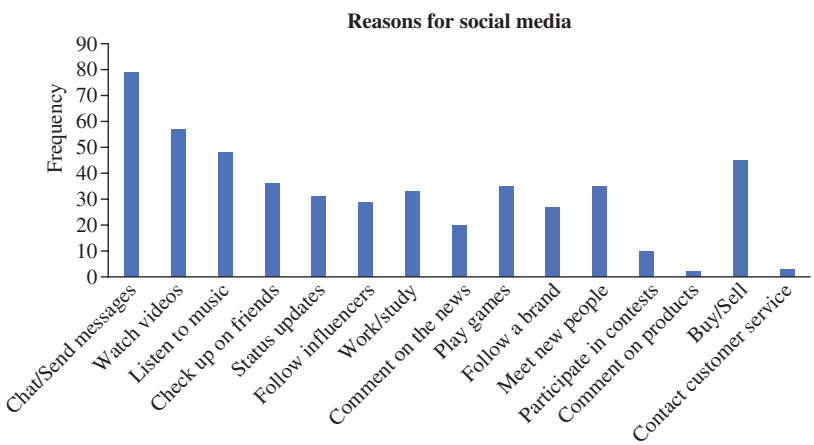


b Yes, Samantha seems to be saving around $30 a week and she has about $190 in Week 9.

8 a column graph

b Columns graphs can show the frequency of multiple categories.

c

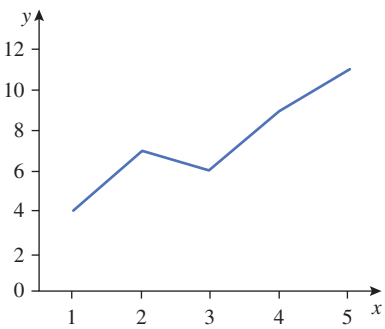


Exercise 6C

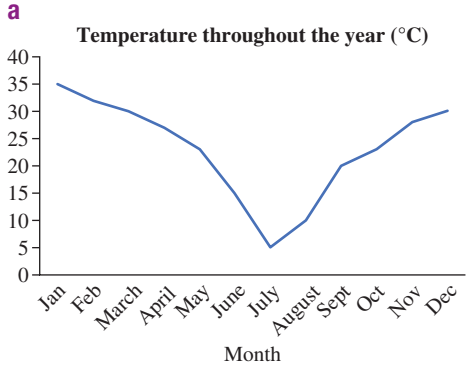
1 a 7

b 11

c



2 a



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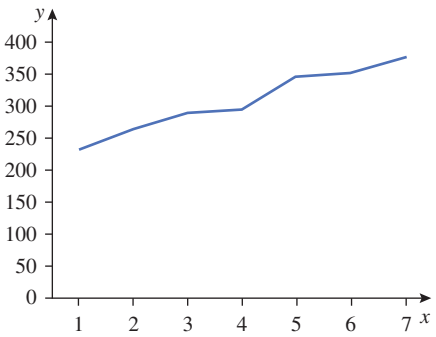
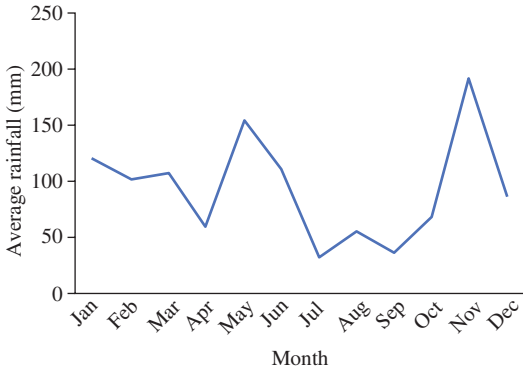
b

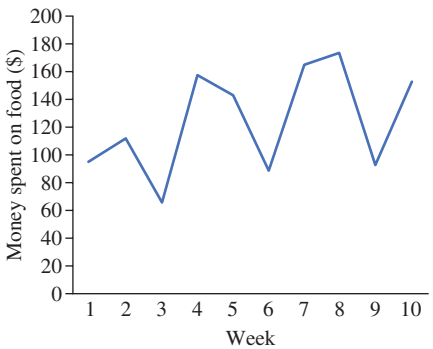


3 a



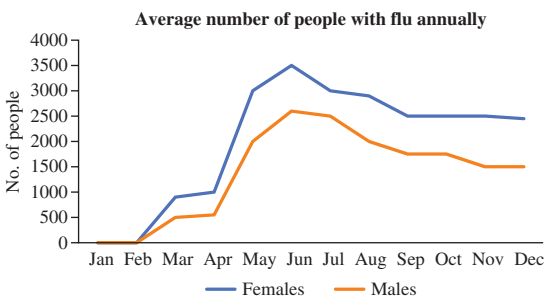
b According to the graph, the wettest months are May and November, and the driest months are July and September.

4 a



b According to the graph, the amount of money that Cameron is spending on food is gradually increasing.

5 a



b From the graph, we can observe that during the summer months of January and February fewer people catch the flu. Females seem to catch the flu more frequently than men.

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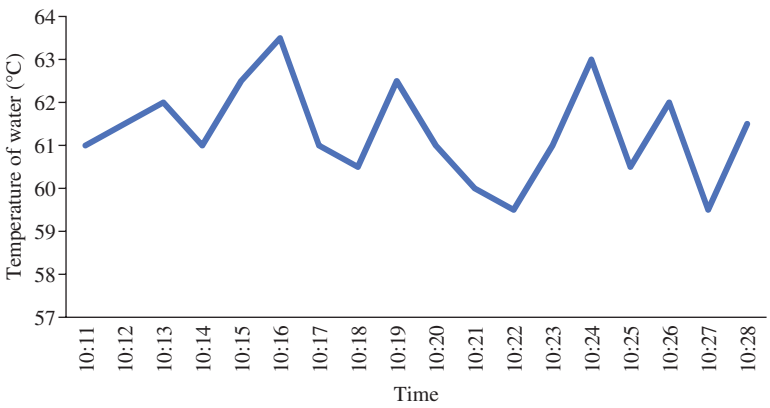
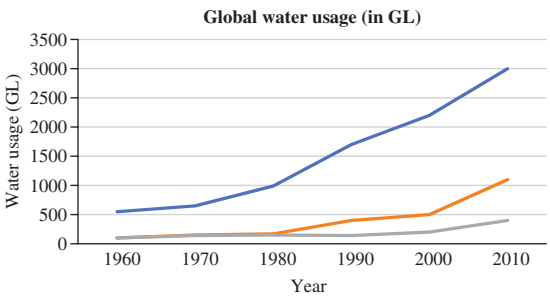
6 a



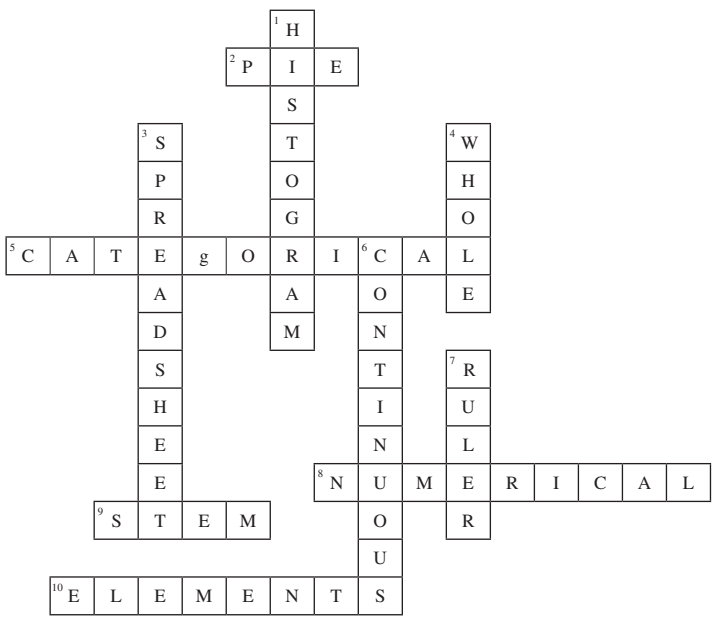
b This hot water boiling system is not working efficiently, as the temperature drops below 61°C on numerous occasions.

7 a



b All types of water usage is increasing as time passes, although agricultural water usage is growing the most rapidly compared to other usage types.

Puzzle



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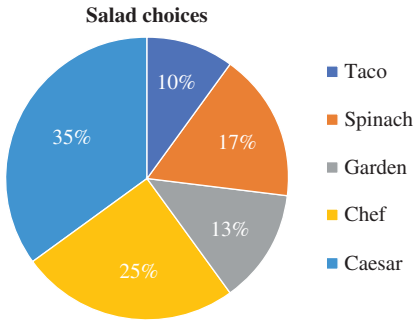
Chapter checklist

1 bar graph

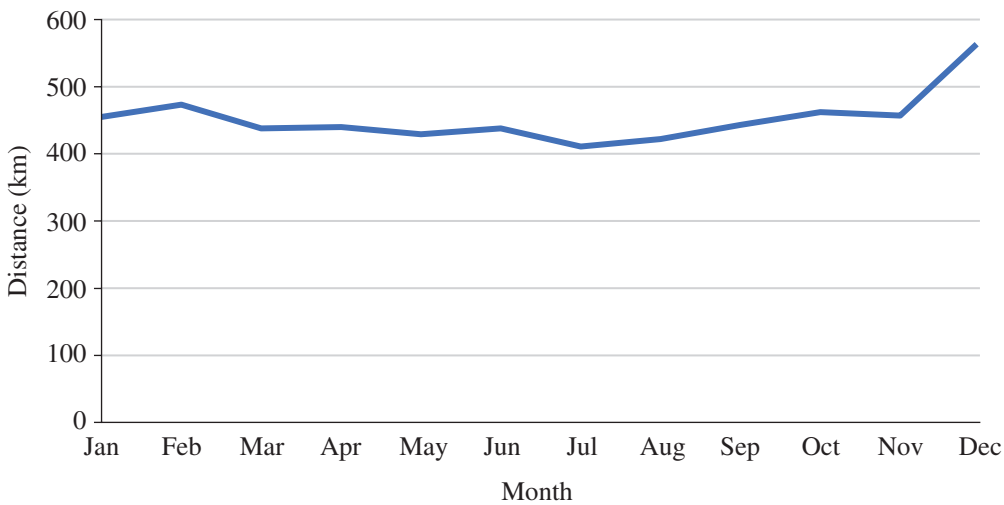
2

Response	Frequency
Strongly agree	2
Agree	4
Neutral	2
Disagree	5
Strongly disagree	7

3



4



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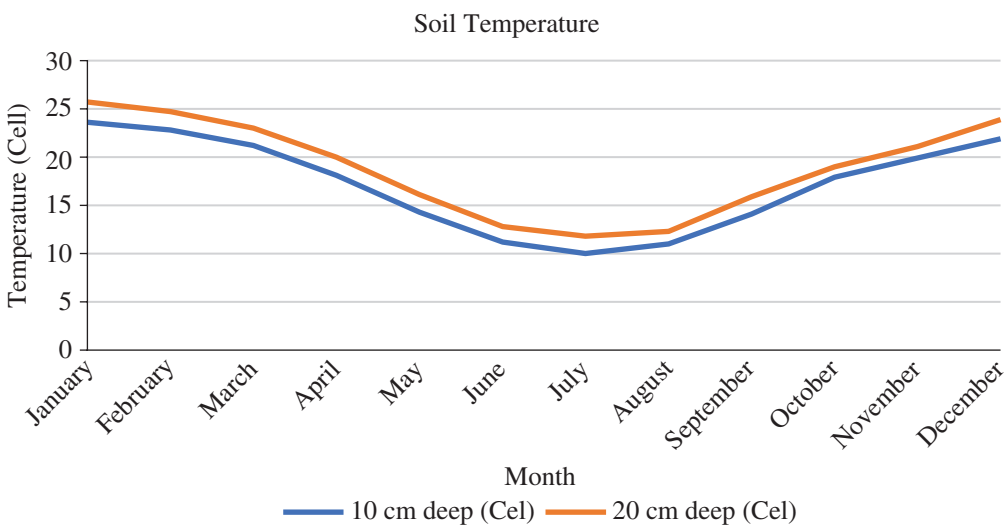

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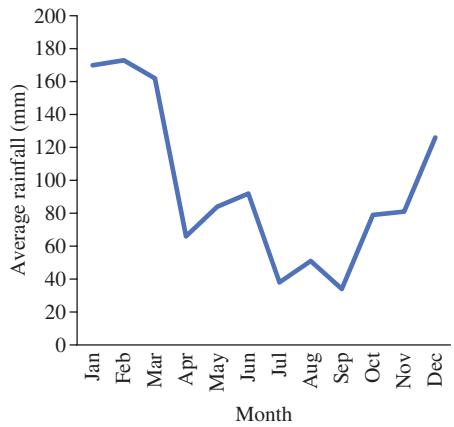
Chapter review

1 pie graph

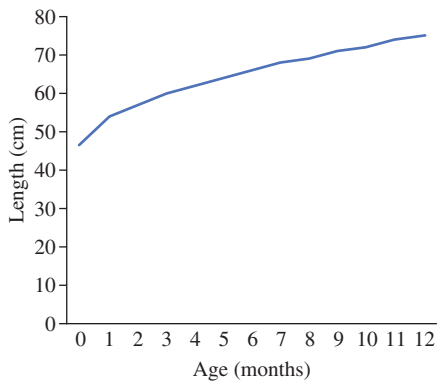
2 histogram

3 a



b We can conclude from the graph that the wettest month is February and the driest month is September.

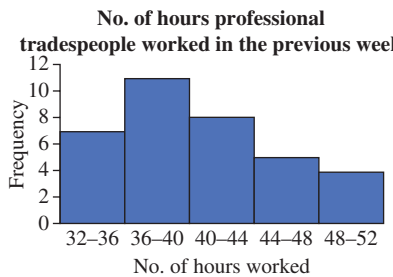
4



5

Response	Frequency
very positive	5
positive	8
neutral	3
negative	2
very negative	2

6

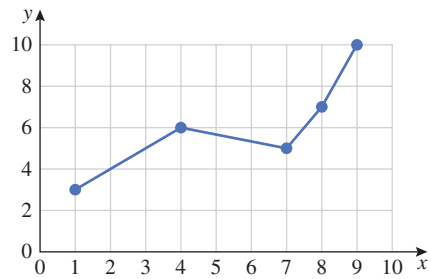


Chapter 7

Pre-test

1 **a** 6 **b** 9 **c** red **d** 3

2 **a, b**



c 6 **d** 8

3 **a** 4 **b** 7 **c** 18 **d** 9

Exercise 7A

1 **a** 6 **b** 21 **c** 5 **d** 9

2 **a** \$300 **c** 4 years
b \$450 **d** 1 year

3 **a** 0.4 V **c** 1 A
b 1.7 V **d** 0.5 A

4 **a** 0.5 km **b** 30 min **c** 1 km

5 **a** \$160 000 **c** 120 000 km
b \$70 000 **d** 500 000 km
e Even if a school bus is broken down and cannot be driven, there would be value in its parts.

6 **a** 200 kg **c** 6.5 months
b 420 kg **d** 14 months

7 **a** 80 b.p.m. **c** 36 min
b 13 min **d** 7 min

8 **a** limousine \$70 000, Hummer \$160 000
b \$27 000
c \$53 000
d 5 years
e 2 years
f limousine \$5000, Hummer \$30 000. After 15 years, the value of each vehicle does not decrease by much each year, remaining around the stated values.

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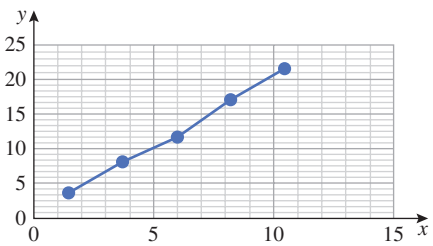
9 a The highest rainfall occurs during December and is lowest in June.

b Highest and lowest temperature occurs in January and July, respectively.

c Answers may vary. For example: If the resort is in the Northern Hemisphere, then travelling during Southern Hemisphere winter time will be best; i.e. June, July and August. Otherwise December, January and February are the best times during the year.

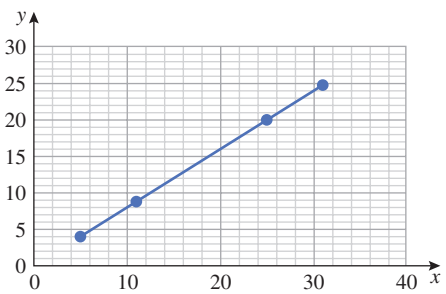
Exercise 7B

1 a

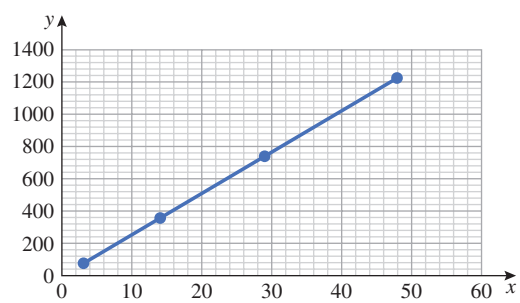


b 14 **c** 5

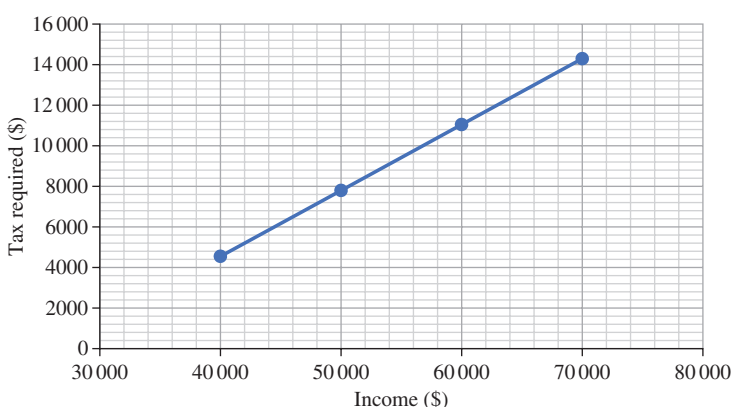
2 a



b



3 a



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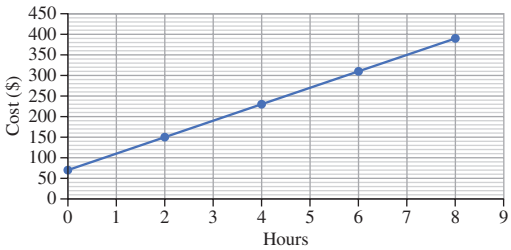
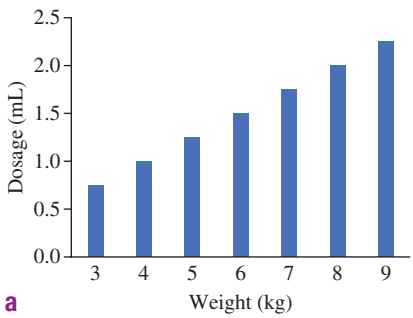
b $9400

4 a

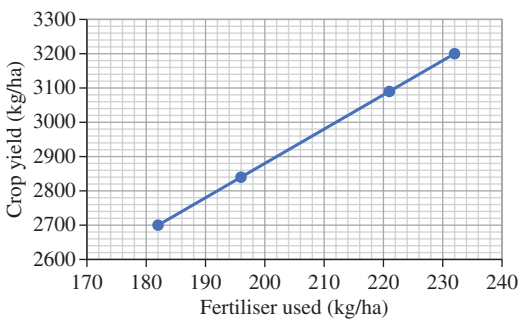


b $270

5



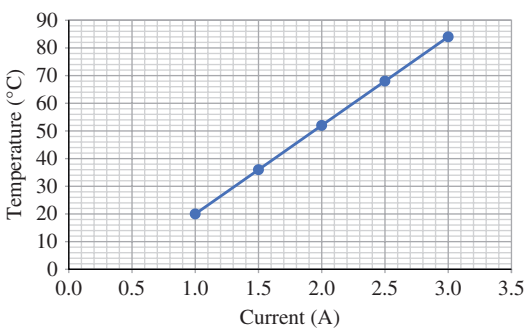
6 a



b 2880 kg/ha

c 187 kg/ha

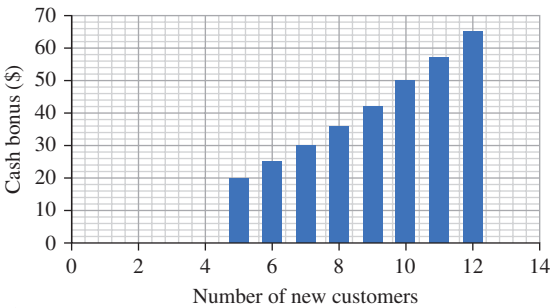
7 a



b 46°C

c 3.2 A

8 a



b Answers will vary.

Exercise 7C

1 a 3 **b** 6.5 **c** 6
d 9 **e** 8 **f** 16

2 a $x = 4, y = 8$ **b** $x = 12, y = 10$
c $x = 2, y = 8$

3 a $5000 **b** 16
c $6000; i.e. the initial amount of money that was owed.
d 24 months; i.e. the amount of time it will take to pay off the debt.

4 a i $35 **ii** $62 **iii** $27
b $15
c Make-up bags = 30, revenue & expenses = $105; this is the break-even point. Selling fewer than 30 bags will result in a loss and selling more than 30 bags will result in a profit.

5 a 60 **b** 15
c Child tickets = 140; this represents how many child tickets are required to be sold to make $350.
d Adult tickets = 70; this represents how many adult tickets are required to be sold to make $350.

6 a Total costs = $480; this represents the total fixed cost.
b $250 loss **c** $150 profit
d sales volume = 20 units
e total sales = total costs = $800

7 a $120 000 **b** $40 000
c $200 000; this represents the initial value of the utility tractor.

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d 25 years; this represents after how many years the utility tractors will be effectively worth nothing.

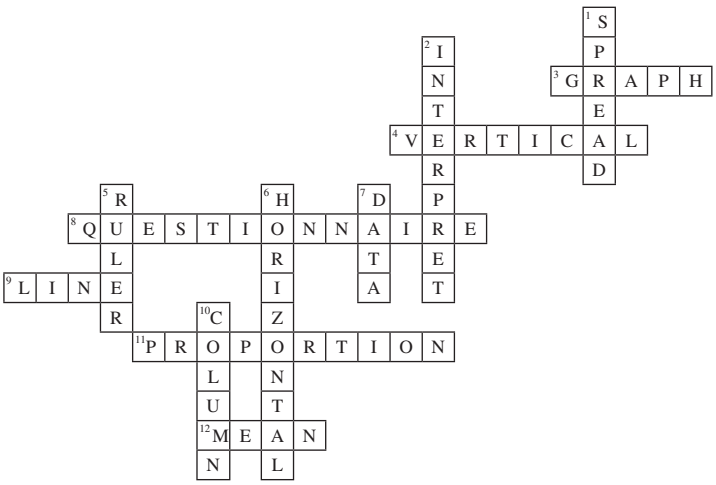
e $280 000; this represents the initial value of the row crop tractor.

f 20 years; this represents after how many years the row crop tractors will be effectively worth nothing.

g Time = 13.5 years, value = $95 000; this represents when the two tractors are worth the same amount.

h utility tractor 19 years, row crop tractor 16.5 years

Puzzle

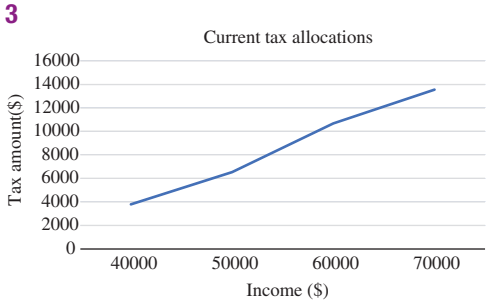


Chapter checklist

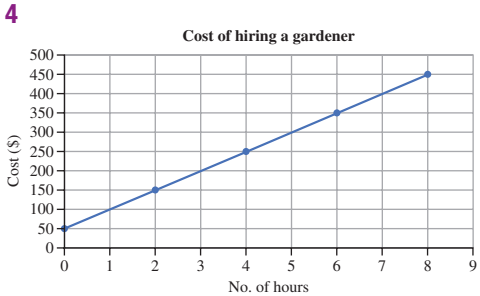
1 distance 35 km, time 255 min

2 4 g

3



4

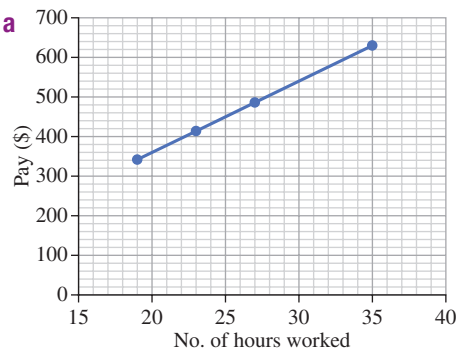


5 ~$900

6 The point of intersection occurs at 15 cakes and is approximately $1250. This means that if the company sells fewer than 15 cakes, it will make a loss. If it sells more than 15 cakes, it will make a profit. This is the break-even point.

Chapter review

1 a



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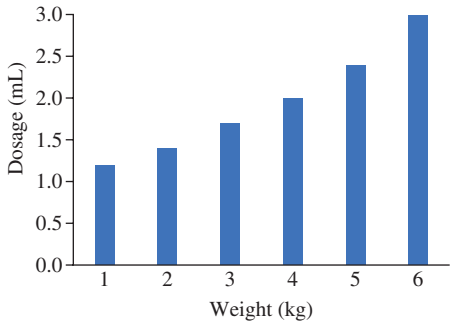
b $540

c 17 h

2



3 a 20.5°C

b 22.8°C

c between 12:30 hours and 13:00 hours

d Turned off at13:30 hours since after this time the temperature of the water starts to decrease.

4 a 750 km

b 14 h

c Distance = 1000 km; this represents that, initially, Frankie was 1000 kmfrom Alice Springs.

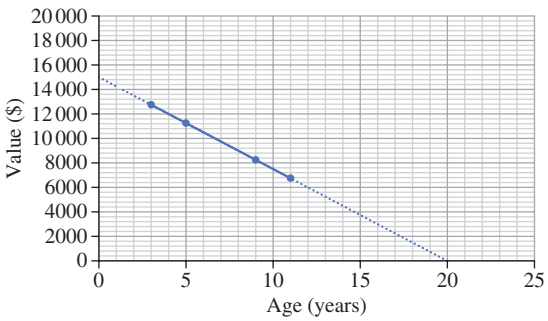
d Time = 24 h; this represents how long it took to reach Alice Springs on the train.

5 a 42 psi

b 51 psi

c 16 m

6 a



b $9600

c 6.5 years

d Value = $15 000; this represents the initial value of the range of motion machine.

e Age = 20 years; this represents after how long the range of motion machine is effectively worth nothing.

7 a $900 loss

b $300 profit

c $1200; this represents the initial cost of making the headphones, which is a one-off fixed cost.

d Headphones = 20, revenue & expenses = $1600; this is the break-even point. Selling fewer than 20 headphones will result in a loss and selling more than 20 headphones will result in a profit.

8 a $24 000

b $48 000

c 15 years

d 11.5 years

e Debt = $50 000; this represents the initial amount that Josh must pay.

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f Debt = $55 000; this represents the initial amount that Lindsey must pay.
g Time = 19 years; this represents how long it will take for Josh to pay off his debt.
h Time = 16 years; this represents how long it will take for Lindsey to pay off her debt.
i Time = 6 years, debt = $34 000; this represents when both Josh and Lindsey have the same amount of debt to pay back.

Chapter 8

Pre-test

1 a 04:45 hours **b** 10:30 hours
c 12:25 hours **d** 17:50 hours
e 22:33 hours **f** 00:40 hours
2 a $180 **b** $175 **c** $215
3 a 8:30 a.m. or 08:30 hours
b 9:30 a.m. or 09:30 hours
c 9:45 a.m. or 09:45 hours
4 a $52 250
b $73 870
c $75 253.75
5 a 32 h **b** 31.85 h **c** 57.5 h

Exercise 8A

1 a employed **b** employee
c employer **d** p.a., annum
e salary **f** wage
g gross pay **h** net pay
2 A and e, B and d, C and k, D and b, E and a, F and i, G and j, H and l, I and f, J and g, K and c, L and h
3 wage: penalty rates, casual, overtime, hourly rate of pay, payslip, income, timesheet, allowances
salary: regular set income per pay period, income, paid sick-leave, set annual amount, paid annual leave, payslip
4 a 7 h **b** 11 h
c 5 h **d** 6.5 h
e 6.5 h **f** 6.75 h
g 6.75 **h** 7.25 h
i 6.25 h **j** 7.75 h
5 a $81.65 **b** $198.41
c $201.69 **d** $153.76
e $280.25 **f** $91.46
g $125.736
6 a wage **b** 74 h **c** $21.90
d $1620.60 **e** $1386.60
7 a wage **b** 76 h
c $1888.60
d $6846.00
e $40 627.60
8 a 21.75 h **b** $598.13
9 a 10 h
b 2.5 h
c 40 h 30 min = 40.5 h
10 $192.50
11 $365.70
12 a $21.50 **b** 37.5 h
c $806.25 **d** $691.25
13 a i 4.5 h **ii** 5.5 h
iii 6.5 h **iv** 7 h
v 30 min **vi** 5 h 30 min
vii 4 h **viii** 38.5 h
b $903.98

Exercise 8B

1 a overtime **b** twice
c time, half **d** penalty
2 a 12 h **b** 10 h
c 13 h **d** 8.25 h
e 20.5 h **f** 18.75 h

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3 **a** $21.57 **b** $23.44
c $58.20 **d** $32.04
e $32.80 **f** $47.35
4 **a** $47.55 **b** $63.40 **c** $79.25
5 **a** 0.5 h or 30 min
b 1.5 h or 1 hr 30 min
c 1.75 h or 1 hr 45 min
d 0.25 h or 15 min
e 2 h
f 0.75 h or 45 min
6 $616.80
7 $342.00
8 $371.25
9 $88.44
10 $1440.60
11 $1152.90
12 $240.87
13 $189.23
14 **a** 7.5 h **b** 7.5 h
c 15 h **d** 48.5 h
15 **a** $343.90 **b** 30 min
c $316.75 **d** 9 h 45 min
e 1 h 45 min **f** $384.63
g $357.48 **h** 8 h
i 44.5 **j** 4.5
k $1692.36

Exercise 8C

1 **a** not **b** retainer
c piecework **d** commission
2 **a** $350 **b** $1629.36
c $3471 **d** $7321.97
e $3663.19 **f** $4789.70
g $2887.50 **h** $5700
3 **a** $267 **b** $404.97 **c** $651
4 **a** $30 **b** $50 **c** $64
d $112 **e** $214 **f** $742
5 $2275.20
6 **a** $386.96 **b** $450.75
c $587.97 **d** $847.33
7 $5400
8 $1075.55
9 $4317.80
10 $1081.87
11 $7610
12 $490
13 $243
14 $150.70
15 $111.20
16 $244.80
17 **a** **i** 8 **ii** $224
b **i** 12 **ii** $336
c **i** 13.5 **ii** $378
18 $1116
19 $14.25
20 $7.70
21 $811.75

Exercise 8D

1 **a** 365 **b** 52 **c** 26
d 52, annual or yearly, 12, monthly
e 12, annual or yearly, 52, weekly
2

Weekly income	a Estimated monthly income	b Actual monthly income
$475.80	$1903.20	$2061.80
$960.75	$3843	$4163.25
$1178.95	$4715.80	$5108.78
$1510.80	$6043.20	$6546.80

c Actual monthly income is greater because estimated income uses only 4 weeks (i.e. 28 days) but actual income uses a whole month (~30 days).
3 **a** $1000
b $2000
c $4333.33
4 **a** $2046 **b** $53 196 **c** $4433
5 **a** $38 553.60
b $741.42
c $1482.83
6 **a** $573.21 **b** $1146.42
c $29 806.92 **d** $2483.91
7 $61 748.40

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8 $2528.77
9 $32 740.80
10 **a** $43 193.80
b $36 797.80
c $6396
11 **a** $1861.15 **b** $45.39
12 $27.45 per hour
13 Balance Accountancy = $45 730 p.a., We All Count Accountancy = $46 667.40 p.a. Therefore, We All Count pays the most.
14 Tristan = $370.65, Tamsyn = $360 per week. Therefore, Tristan earns the most.
15 **a** $1809.03 **b** $47 034.65
16 Sam = $4333.30, Miguel = $4449.99 per month. Therefore, Sam earns the least amount of money. Miguel has worked out his monthly income incorrectly by multiplying by 4.

Exercise 8E

1 **a** superannuation
b employee, superannuation
c tax
d Tax File Number, TFN, tax, super
e Pay As You Go (PAYG), annual
2 **a** $132.81 **b** $234.50
c $426.34 **d** $939.53
e $1777.55 **f** $2647.21
3 **a** true **b** false **c** true
d true **e** true **f** true
g false
4 **a** nil
b 19c for each $1 over $18 200
c 19c for each $1 over $18 200
d $3572 plus 32.5c for each $1 over $37 000
e $3572 plus 32.5c for each $1 over $37 000
f $19 822 plus 37c for each $1 over $90 000
g nil
h $54 097 plus 45c for each $1 over $180 000
5 **a** No, he does not work 30 h per week.
b yes **c** no **d** no
e yes **f** yes **g** yes
6 $126.06
7 $336.62
8 $6590.63
9 **a** nil **b** nil **c** $195.36
10 **a** yes **b** $13 435
c $57 854 **d** $44 419
e no **f** $5496.13
11 **a** yes
b Allan would need to pay more tax.
c $15 300 **d** $61 264
e $45 964 **f** no
g $5820.08

Exercise 8F

1 **a** Australian Taxation Office, ATO, withheld
b tax-free, not
2 **a** nil **b** nil **c** $26
d $40 **e** $48 **f** $50
3 **a** $144 **b** $192 **c** $262
d $320 **e** $334 **f** $196
g $190 **h** $118
4 **a** $797 **b** $858 **c** $975
d $1179 **e** $1309 **f** $1369
5 **a** $40 **b** $476
6 **a** $374 **b** $952
7 **a** $1066 **b** $2548
8 $1336
9 $3076.33
10 $855
11 $4861.67
12 **a** $816 **b** $1632 **c** $3535.67

Exercise 8G

1 **a** net, gross
b deductions
c taxable, tax deductions

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2 **a** $234.30 **b** $814.44
c $1620.30 **d** $2078.34
e $3227.40
3 **a** $72 **b** $198
c $39 **d** $208
4 $58 762.60
5 $41 186
6 $46 588.30
7 $58 137.60 p.a. − $160 − $170 − $140 − $25 − $40 − $80 − $178.20 = $57 344.40
8 $71 800 p.a. − $140 − $19 − $1870 − $150 − $672 − $80 − $390 − $207 = $68 272
9 $53 599 p.a. − $180 − $37 − $108 − $811.80 = $52 462.20
10 $51 700 p.a − $210 − $180 − $80 − $50 − ($15 × 52 × 0.3) − (3795 × 0.66) = $48 441.30
11 **a** $29913 p.a **b** $1375
c $25604.80

Exercise 8H

1 **a** Medicare, 2
b gross, deductions
c Medicare, surcharge
d tax
e Medicare, Medicare levy, Medicare levy surcharge
2 **a** $775 **b** $891.20 **c** $1024
d $1312 **e** $1610 **f** $2038
g $2761.20 **h** $5140
3 **a** 2% **b** 3% **c** 3.25%
d 3.5% **e** 3.25% **f** 3%
4 **a** Green: $3700, Wu: $3840, Johnston: $4372.84, Russo: $5188.74, Nguyen: $6784, Kumar: $11 712.74
b Green: $5550, Wu: $5760, Johnston: $7105.87, Russo: $8431.70, Nguyen: $11 872, Kumar: $20 497.30
c Green: $1850, Wu: $1920, Johnston: $2733.03, Russo: $3242.96, Nguyen: $5088, Kumar: $8784.56
5 $1530
6 $1951.60
7 $3470.35
8 $5026
9 $3370
10 $5718
11 **a** $76 336 **b** $1526.72
12 $2781
13 $1287.42

Exercise 8I

1 **a** payment, income, tax
b Pay As You Go
c income, gross, deductions
d PAYG, tax return
e Australian Taxation Office
f not, difference
g income, rates, cents
2 **a** $48 385.40
b $91 515
c $76 640.60
3 **a** $1570 **b** $3737.50
c $2189 **d** $7626.50
4 **a** nil
b 19c for each $1 over $18 200
c 19c for each $1 over $18 200
d $3572 plus 32.5c for each $1 over $37 000
e $20 797 plus 37c for each $1 over $90 000
5 $20 660.50
6 $13 939.50
7 $11 664.30
8 $11 380.72
9 **a** $57 278
b $10 162.36
c $1145.56
d $13 435 − $11 307.92 = $2127.08 tax refund
10 $7682.89 tax refund
11 $1661.80 tax debt
12 $5533.36 tax refund

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Puzzle

Medical sonographer

Review checklist

1 Salary earns a set amount of income, regardless of the number of hours worked; wage earns money per hour or per item.
2 $238.70
3 $100.80
4 $900
5 9.5%
6 Paying tax provides goods and services to the community; e.g. roads, electricity, local parks etc.
7 Individual pays more tax.
8 a Indicates how much some one has been paid and how much tax they paid as well as YTD values.
b Amount of time worked by some one during a time period (ie. fortnight)
c Summary of tax paid through PAYG showing gross payments and tax withheld.
9 a $27.50 b 33 h
c $907.50 d $155
e $752.50 f $86.51
10 a $936.54 b $1873.08
c $4058.34 d $24.65
11 $1209.23
12 a $0 b $0
c $16 d $41
13 a Gross income is the amount of money earnt before tax is deducted. Net income is the money received after tax has been deducted.
14 $38 866.60
15 $777.32
16 $3090.95 tax refund

Chapter review

1 $69.75
2 a 52.25 h b $1280.13
3 $525.10
4 a $267.90 b 30 min
c $246.75 d 45 min
e $257.33 f $278.48
g $225.60 h 3.5
i $1276.06
5 $1560
6 $4317.80
7 $947.50
8 a nil b nil c $222.86
9 a yes
b Allan would pay more tax.
c $15 300 d $61 264
e $45 964 f no
g $5820.08
10 George $21.65, Roberta $21.73; therefore, Roberta earns the most per hour.
11 $47 320.04
12 a $381.48 b $237
13 a $25 521.60 b $1290
c $22 224.80
14 a $713 b $835.20 c $984
15 a $1730 b $3091.20
c $4494.75 d $5237.16
16 $15 124.30
17 a $67 798
b $13 581.35
c $1355.96, $14 937.31
d $2862.69
18 $55748, $1114.96
19 $1127.85

Chapter 9

Pre-test

1 a $535
b $625; hence, Elisa can support herself.
c 3.5 h
d if she spends less money on things like food and entertainment she can reduce her hours even more
2 a $1120 per week
b $878.42 per week

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c $21 632 per year
d $2353 per month

3 Alliance ($16.83 per week) is the cheapest, followed by CARmi ($17.31 per week) and MRNA ($18 per week).

4 $302.5

5 Tax per week is $246.94 including the Medicare levy, so she has $987.86 left to spend per week.

6 **a** earns $807.69 per week
b spends $692.46 per week
c loses $307.92 per year
d saves $142.08 per year

Exercise 9A

1 **a** cents, kilowatt hour
b cheaper, less
c peak, higher, higher
d volume, metre
e rates, services
f daily cost, 14
g daily charge, 12

2 **a** **i** 1 month **ii** $106.58
iii $0.1527 **iv** 698
b 2019 when referring to the graph

3 **a** **i** 6 months **ii** $692.03
iii $27.75 **iv** $172 500
b General, waste disposal, heritage levy, environment, transport, state emergency management.

4 **a** 96 days
b $603.98
c $367.22
d It is hotter in those months so he may have used more water for his garden perhaps.

5 **a** 1 month **b** $351.17
c $176.17 **d** $15
e 2 **f** $45

6 **a** $40.32 per week
b $80.64 per fortnight
c $175.20 per year
d $2102.52 per month

7 **a** $1328.56 per year
b $51.10 per fortnight
c $110.71 per month

8 **a** $6.291 per day
b $44.037 per week
c $88.074 per fortnight
d $2296.214 per year
e $191.35 per month

9 **a** $2133.24 per year
b $82.05 per fortnight
c $41.02 per week

10 **a** Yes, Rory has saved $660.
b $126.65
c **i** $177.78 per month
ii $82.05 per fortnight

Exercise 9B

1 **a** expenses **b** fixed
c variable **d** change
e 4, 3, 12 **g** 2
f 26

2 **a** V **b** V **c** F
d V **e** F **f** F
g F **h** V **i** V
j F **k** V **l** V
m F **n** V **o** V
p V **q** F **r** F
s F **t** V **u** V
v V

3 **a** true **b** true **c** true

4 **a** $16 120 **b** $948
c $1788 **d** $1080
e $30 932.20 **f** $1056
g $1750 **h** $708
i $1160

5 **a** $431 in weekly fixed expenses
b $422 in weekly variable expenses
c Michael could reduce any of his variable expenses, such as entertainment, food or clothing.

6 $1577.01 in expenses per fortnight

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7 WeHelp $925.60, Insurance4U $902.40. Even though Insurance4U still goes over her budget, it is the closest one that falls within her allowed budget.

8 Ryan could adjust his entertainment expenses and perhaps find better ways to commute rather than always using his car.

Exercise 9C

1 **a** 12 **b** 52 **c** 12, 52
d 52 **e** 12 **f** 52, 12

2 Income $895 per week, expenses $875 per week; yes, Valerie should have $20 per week extra.

3 $300 per month

4 $2977 p.a.

5 **a** $3090 **b** $4350 **c** $15 120

6 $67.38

7 Yes, Andrew earns enough money. He will have $25.84 remaining per fortnight.

8 **a** $4367.16

b $191.16

$4558.33 − $4250.16 = $308.17 could be possibly saved per month.

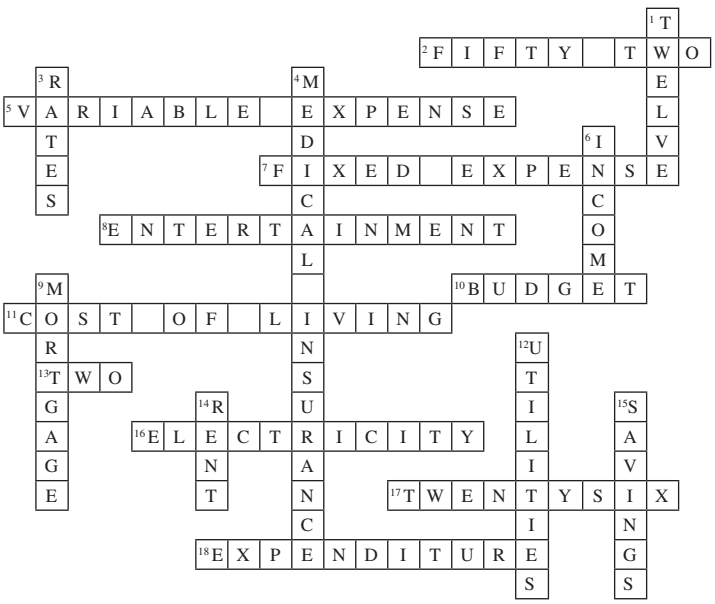
9 **a** −$57.14 per month

b Any answer with suggested change to variable amounts (at least reduce $57.14 per month) is acceptable. For example: Finnley could reduce petrol expenses by $37.14 per month and clothes by $20 per month.

10 61 weeks

11 $19 300 ÷ $1478.76 = 13.05 months, so it will take 14 months.

Puzzle


1 T
2 F I F T Y T W O
3 R E
4 M
5 V A R I A B L E E X P E N S E L
T D 6 I V
E 7 F I X E D E X P E N S E
S C C
8 E N T E R T A I N M E N T O
L M
9 M 10 B U D G E T
11 C O S T O F L I V I N G
R N 12 U
13 T W O S T
G U I 15 S
14 R
A 16 E L E C T R I C I T Y L A
G N I V
E T A N 17 T W E N T Y S I X
C I N
18 E X P E N D I T U R E G
S S

Chapter checklist

1 **a** 96 days

b $618.24

c $6.44

d 18.70 kWh

e increased

f 4 people or possibly 5 people who are conservative with water

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2 **a** $1798.33 per month
b $20.54 per week
c $1404 per year
d $26.54 per week
e $27.69 per fortnight
f $708 per year
g $32.31 per fortnight
h $23 725 per year

3 **a** $3980.83 in monthly expenses
b $285.83 possible savings per month
c

Annual budget for Alex	
Annual Income	$51,200
Expenses	
Mortgage	$21,600
House and contents insurance	$1164
Electricity bills	$1144
Water bills	$780
Rate	$1720
Mobile phone and internet bundle	$948
Private health insurance	$1464
Car loan	$2704
Car registration	$670
Petrol	$3120
Entertainment	$5200
Food	$5720
Clothes	$960
Charity donations	$576
Total annual expenses	$47,770
Surplus/savings	$3430

Chapter review

1 **a** 6 months **b** $772.55
c $179 800
d Council rates contribute towards Waste Bin collection, Heritage levy, environment levy, transport levy and State emergency management levy.

2 **a** V **b** V **c** F
d V **e** F **f** F
g F **h** V **i** V
j F **k** V **l** V
m F **n** V **o** V
p V **q** F **r** F
s F **t** V **u** V

3 **a** Yes, it covers her expenses.
b No, she won't be able to afford lunch.

4 **a** $1545.10 per year
b $59.43 per fortnight
c $128.76 per month

5 **a** $431 weekly fixed expenses
b $422 weekly variable expenses
c Aedan could reduce how much he spends on food, clothing, entertainment; i.e. any variable amount.

6 Lucas has $478.15 per fortnight to spare.

7 13.46 fortnights = 14 fortnights

Chapter 10

Pre-test

1 **a** 12:00 hours **b** 3:17 hours
c 7:30 hours **d** 4:45 hours
e 9:15 hours **f** 10:55 hours

2 **a** 120 s **b** 1800 s **c** 7200 s

3 **a** 12 h **b** 84 h **c** 336 h

4 **a** nine o'clock **b** half past four
c quarter to twelve
d quarter past eight
e twelve minutes past twelve
f eleven minutes to seven

5 **a** 9:15 a.m. **b** 5:30 p.m.
c 11:45 p.m.

6 **a** 5:15 p.m. **b** 6:45 p.m.
c 4:45 a.m.

7 **a** 8:00 a.m. **b** 9:30 p.m.
c 1:40 p.m.

Exercise 10A

1 **a** hours, minutes, seconds
b divide, 60

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c **i** multiply, 60, seconds
ii 3600
d **i** 60 **ii** 60
e midnight

2 **a** 8:26:05 **b** 10:08:58
c 2:53:37

3 **a** **i** $5\frac{1}{4}$
ii quarter past five
b **i** $15\frac{1}{3}$
ii twenty minutes past seven
c **i** $12\frac{1}{2}$
ii half past twelve
d **i** $10\frac{3}{4}$
ii quarter to eleven
e **i** $18\frac{1}{2}$
ii half past six

4 **a** 9.58 **b** 17.72 **c** 12.3
d 1.92 **e** 3.275 **f** 20.56
g 11.40 **h** 21.14

5 **a** 10:30 **b** 9:42 **c** 5:18
d 12:48 **e** 7:06 **f** 1:17:24
g 3:33 **h** 7:22:48 **i** 11:46:48
j 2:56:24

6 **a** 08:37 **b** 16:48 **c** 12:28
d 01:55 **e** 03:16 **f** 20:33
g 11:23 **h** 00:08

7 **a** 9:35 a.m. **b** 3:33 p.m.
c 12:49 p.m. **d** 1:55 a.m.
e 9:25 a.m. **f** 5:16 p.m.
g 11:23 p.m. **h** 1:45 p.m.
i 12:12 a.m. **j** 11:50 a.m.

8 **a** 7.5 h **b** 4.75 h **c** 9.25 h
d 5.33 h **e** 6.67 h **f** 7.42 h

9 40.92 h

10 **a** 1.04 **b** 1.21 **c** 1.35
d 1.29 **e** 1.22 **f** 1.03

11 **a** 1:01:58 is faster, which is 1.03 in decimal form. Whereas the decimal form of 1:02:30 is 1.04, which is larger. Therefore, the runner who finished fastest is the student with the time of 1:01:58.
b 1.03, 1.04, 1.21, 1.22, 1.29, 1.35

12 40 h 48 min

13

Date	Start time	Finish time
Monday 3/3/19	8:30 a.m.	1:30 p.m.
Tuesday 4/3/19	8:30 a.m.	4:30 p.m.
Thursday 6/3/19	1 p.m.	5 p.m.
Friday 7/3/19	11 a.m.	8 p.m.

14 23:40 hours

15 **a** 14:40 hours
b **i** 3 h 55 min **ii** 15 h 55 min

Exercise 10B

1 **a** 24 **b** 60
c 60 **d** 12:00, night
e 11:40 p.m. **f** 12:40 a.m.
g p.m., day

2 **a** 6 h 40 min **b** 2 h 45 min
c 1 h 21 min **d** 6 h 25 min

3 **a** 12:50 p.m. **b** 4:35 a.m.
c 2:37 a.m. **d** 7:07 p.m.
e 11:59 p.m.

4 **a** 10:02 a.m. **b** 7:22 a.m.
c 10:07 a.m. **d** 5:12 p.m.
e 11:57 p.m.

5 **a** 3 h 45 min **b** 2:25 p.m.
c 4:47 p.m. **d** 10 h 46 min
e 12:18 p.m. **f** 10:57 a.m.
g 6 h 42 min

6 **a** 3 h **b** 7 h
c 16 h **d** 11 h

7 2 h 45 min, so Jan could have a fine.

8 4 h 27 min **9** 7 h 15 min

10 2 h 13 min **11** 10 h 52 min

12 5 + 4.5 + 4.5 + 7 = 21 h

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13 12:45 p.m. **14** 3:19 p.m.
15 Movie would finish at 11:05 a.m., so they could still make the appointment on time.
16 7:35 a.m.
17 11:23 a.m.
18 6:53 a.m.
19 **a** 11:35 a.m. **b** 2 h 15 min
c 1 h 30 min **d** 1:35 p.m.

Exercise 10C

1 **a** location, stops, stations
b departures
c departure/arrival, stop, route
2 **a** six times per day
b six stops, including City Parklands
c 5:07 p.m. and 7:05 p.m. Entertainment centre and factory outlets are probably closed at these times so there's no need to stop.
d 49 min **e** 12 min
f 10:27 a.m. **g** 5:44 p.m.
3 **a** 11:56 a.m. **b** 11:12 a.m.
c **i** depart 11:12 a.m.
ii arrive 11:57 a.m.
d 11:54 a.m. **e** 12:32 a.m.
4 **a** Bus will arrive at Hospital bus stop at 11:53 a.m., therefore arrive at destination at 12:44 p.m.
b departs 2:46 p.m.
c Yes, Angelo can be there by 11:59 a.m. if he departs at 11:23 a.m.
5 **a** 10:25 a.m.
b Tracey would likely catch the 7:53 a.m. train, as she would need to get through customs and collect her bags. If she catches this train, she would arrive home at 8:27 a.m. If she misses this train, she does not need to worry as the trains arrive in fairly regular intervals.
c 10:10 a.m.
d 1 h 48 min

6

Location	Departure time	Destination	Arrival time
Inter-national	7:38 a.m.	Roma Street	8:02 a.m.
Roma Street	8:30 a.m.	Ipswich	9:26 a.m.

7

Location	Mode	Departure time	Desti-nation	Arrival time
Northcliffe	tram	7:48 a.m.	Helen-svale	8:26 a.m.
Helensvale	bus	8:44 a.m.	Movie World	8:53 a.m.

Suggested travel plan: Depart Northcliffe by tram at 7:48 a.m. and arrive at Helensvale at 8:26 a.m. Depart Helensvale by bus at 8:44 a.m. and arrive at Movie World at 8:53 a.m.

Exercise 10D

1 **a** 3:43 **b** 17 **c** 4:08, 8
d 17, 8, 1 h and 25 min
2 Option 1: 1 h 35 min; option 2: 2 h 5 min. So option 1 is best.
3 Option 1: 28 min; option 2: 26 min. So option 2 is best.
4 **a** **i** 9:57 a.m. bus or 9:13 a.m. train
ii By travel time: bus 16 min, train 10 min
iii According to least amount of travel time, train is the best mode of transport.
b **i** Overall, trains depart from Palmwoods on a more regular basis, but between 12 p.m. and 1 p.m. only one train and one bus departs from Palmwoods station.
ii Option 1: Train departs Palmwoods Station at 12:17 p.m. and arrives at Beerwah Station at 12:41 p.m. plus 6 min bus ride is 30 min total travel time.
Option 2: Bus departs Palmwoods at 12:45 p.m. and arrives at Australia Zoo at 1:18 p.m., so 33 minutes travel time.
iii So option 1 is the best option.

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5 Option 1: tram 18 min; Option 2: bus 32 min. So tram travel is the better option, with choice of arriving at either 8:51 a.m. or 8:58 a.m.

6 **a** Bus route: Catch 5:55 a.m. bus to arrive at South Bank at 6:38 a.m. is 43 min total travel time.
Train route 1: Catch 6 a.m. train to arrive at 6:32 a.m., which is 32 min total travel time.
Train route 2: Ryan could drive to Manly Station instead and catch the express departing at 6:26 a.m., arriving at 6:55 a.m. Total travel time is 29 min (not including driving time).
b bus route takes 43 min, train route 1 takes 32 min, train route 2 takes 29 min
c Answers may vary. Either train route is sufficient as long as answer is justified.

Exercise 10E

1 **a** phase, sunlit **b** sea, gravitational
c two, two **d** two
e locations, times, heights

2 **a** 15 November **b** 1 April
c 5 July **d** November
e May

3 **a** 6:05 p.m.
b Tide lowest at 1.29 m at 10:44 a.m.
c morning
d Wednesday 3rd January 11:00 a.m.
e Wednesday 3rd January at 4:04 a.m. with lowest tide depth of 0.19 m.

4 **a** 6:50 a.m. and 5:47 p.m.
b July 31st
c July 30th and 31st
d July 30th and 31st
e 16 min 10 s

5 6 June or 5 July

6 Sarrita should hold her party on the 14th September as it will be a full moon.

7 **a** 4:49 a.m.
b approx. 6:30 p.m.
c From approx. 5 a.m. to 6:30 p.m.; i.e. 13.5 h available.

8 **a** 5:22 a.m. and 5:55 p.m.
b 97° and 263°
c 2 min

9 **a** Any suggested time between 4:30 a.m. and 7:30 a.m. is correct (allowing for daylight, tides, travel time and maximum time on beach)
b ~ 11:48 a.m. **c** ~ 9:41 p.m.

10 **a** Between 5 a.m. (assuming sunrise) and 7.19 a.m; 5:19 p.m and 7:19 p.m., assuming sunset is somewhere around/ soon after 8:19 p.m.
b 8.19 a.m. or approx. 7–7.30 p.m. (taking into account sunset).
c Assuming earliest start time (5 a.m.) and latest leave time (7.30 p.m.), this would equal approx. 12 h 30 m.

11 **a** 6.71 m increase **b** 1.68 m increase
c 3.36 m increase **d** 1.68 m increase
e 6.51 m decrease **f** 3.26 m decrease

Puzzle

Do not procrastinate.

Chapter checklist

1 $6\frac{1}{4}$ h, six and a quarter hours
2 32.45 h
3 12:30 a.m.
4 15:15
5 6 h 35 min
6 1:05 p.m.
7 Latest time is 9:49 a.m.
8 Option 1:41 min 9:45 a.m. to 10:26 a.m.; option 2:30 min 9:55 a.m. to 10:25 a.m. So option 2 is the best.
9 5:51 a.m.

Chapter review

1 11:00 a.m. to 7:45 p.m.
2 1.094 h

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3 Dimitri's records show 28.75 h; his boss must have rounded to one decimal place.
4 a 1:21 p.m.
b 13 : 21
5 2 h 47 min
6 1:36 p.m.
7 a 6 min
b i 8:04 a.m.
ii Paul could catch the 8:08 a.m. train from Eagle Junction and should arrive at Wooloowin at 8:10 a.m.
c 7:56 a.m. express arrives at 8:05 a.m.
d 7:43 a.m.
8 a 6:04 a.m., 5:41 p.m. on Friday and 9:33 a.m. and 8:58 p.m. on Monday.
b Friday 4:04 a.m. to 8:04 a.m. Friday 3:41 p.m. to 7:41 p.m. Monday 12:33 a.m. to 4:33 a.m. Monday 6:58 p.m. to 10:58 p.m.

Chapter 11

Pre-test

1 a 1000 m b 2350 m c 0.075 m
2 a 3 km b 5.75 km c 0.25 km
3 a 150 km b 112.5 km c 45 km
d 117 km e 1.98 km f 0.297 km
4 a 1128 m b 11250 m c 1.065 m
5 a Arrow is pointing right; i.e. east.
b Arrow is pointing left; i.e. west.
c Arrow is pointing up; i.e. north, which is the same direction as its starting position.

Exercise 11A

1 a map, actual
b larger, map
c segment
d Step 1: line, mm Step 2: mm
Step 3: actual, map, mm, km/mm
2 a i 60 m ii 120 m
b i 800 m ii 6 km
c i 104 m ii 300 m
3 a 16 mm, 5 km/mm
b 22 mm, 27.27 km/mm
c 14 mm, 28.57 km/mm
4 a 28.57 km/mm
b i Measured: 56 mm, Actual: ~1600km
ii Measured: 23 mm, Actual: ~650km
iii Measured: 70 mm, Actual: ~2000km
iv Measured: 29 mm, Actual: ~800km
5 ~12.2 km
6 a ~600 m b ~740 m
c ~600 m
7 a ~640 m b ~612 m
c ~1500 m
8 a ~190 km b ~70 km
c ~200 km
9 Exmouth to Noosa is the larger distance by approximately 220 km.
10 The Queen St Mall is approximately 435 m long and would cost $1 419 840 to resurface.
11 a 2500 m, 2.5 km
b The ferry would take approximately 15 min.
12 a 800 m
b Saanvi would need to leave by 1.44 p.m.
13 a Measured: 32mm, Scale: 18.75 km/mm
b 1800 km
c 212%

Exercise 11B

1 a i scale ratio, map, actual
ii segment
b 1: segment 2: km/mm
3: map, mm, km/mm
2 a i ~258 km ii ~182 km
iii ~192 km
b Route 2: Chinchilla–Condamine–Moraby–Surat is the shortest, with a distance of approximately 182 km.

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3 Rockhampton–Emerald 240 km
Emerald–Charters Towers 387 km
Charters Towers–Mt Isa 707 km
Mt Isa–Bedourie 445 km
Bedourie–Longreach 501 km
Longreach–Emerald 400 km
Emerald–Rockhampton 240 km
Total distance travelled = 2920 km

4 a ~1500 km **b** ~1350 km

c The shortest route is Sydney to Tamworth to Bourke to Dubbo to Sydney.

5 a i Mt Isa–Gregory Downs 200 km
Gregory Downs–Doomadgee 100 km
Doomadgee–Burketown 70 km
Burketown–Karumba 135 km
Karumba–Normanton 40 km
Normanton–Croydon 130 km
Croydon–Burke and Wills Roadhouse 250 km
Burke and Wills Roadhouse –Mt. Isa 180 km
Total distance is 1105 km.

ii Julia Creek–Burke and Wills Roadhouse 200 km
Burke and Wills Roadhouse–Gregory Downs 120 km
Gregory Downs–Doomadgee 100 km
Doomadgee–Burketown 70 km
Burketown–Karumba 135 km
Karumba–Normanton 40 km
Normanton–Croydon 130 km
Croydon–Julia Creek 250 km
Total distance is 1045 km.

b Julia Creek is the most suitable.

6 Cairo–Port Said ~150 km
Port Said–Alexandria ~175 km
Alexandria–Dakhla Oasis ~400 km
Dakhla Oasis–Sohag ~160 km
Sohag–Minya ~150 km
Minya–Beni-Suef ~80 km
Beni-Suef–Cairo ~75 km
Total distance travelled = ~1190 km

7 a

	A	B	C	D	E
1	From	To	Map direct distance in mm	Scale in km/mm	Actual one-way direct distance in km
2	Melbourne	Adelaide	16	35.71428571	444
3	Melbourne	Hobart	15	35.71428571	417
4	Melbourne	Sydney	18	35.71428571	500
5	Melbourne	Canberra	12	35.71428571	333
6	Melbourne	Brisbane	35	35.71428571	972
7				Total	2667
8	From	To	Map direct distance in mm	Scale in km/mm	Actual one-way direct distance in km
9	Sydney	Adelaide	30	35.71428571	833
10	Sydney	Hobart	27	35.71428571	750
11	Sydney	Melbourne	18	35.71428571	500
12	Sydney	Canberra	6	35.71428571	167
13	Sydney	Brisbane	19	35.71428571	528
14				Total	2778

b

15	PFD Melbourne	PFD Sydney
16	1370 km	2140 km

c Sydney, as the distance between cities is not that much greater than Melbourne, but there is a much higher profitable flight distance for Sydney. One consideration is where the most popular places are for deliveries and prioritise making the distances to those cities minimal.

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Exercise 11C

1 **a** distance, direction
b north-east, east, south-east, south, south-west, west, north-west (clockwise)
c east, west
d right, left

2 **a** north **b** east
c south **d** west
e south-west **f** north-west
g north-east **h** south-east

3 **a** Zoe **b** Ian
c Doug, Than **d** Than
e Ian **f** Than
g Rose, Lynn **h** Emma, Prisha

4 **a** Casino
b Caboolture
c Brisbane
d Tewantin
e Kingaroy or Murgon
f Casino or Lismore
g Toowoomba, Nambour
h Dalby

5 **a** ≈ 450 km NE **b** ≈ 350 km N
c ≈ 780 km S **d** ≈ 610 km SW
e ≈ 1250 km NW **f** ≈ 450 km W
g ≈ 500 km SW **h** ≈ 1040 km E

6 **a** NW ~800 km **b** N ~300 km
c NE ~410 km **d** SW ~600 km
e W ~550 km

7 **a** Captain Jack should go ≈110 m NW to the lagoon and then ≈165m NW to the treasure.
b The crew will go ≈ 75 m NE to the rock, then ≈ 75 m W to the lagoon, then ≈ 100 m NE to the sunflowers, and then ≈ 270 m W to the treasure.

8 **a** **i** Albany–Meekatharra 900 km N
Meekatharra–Warburton 800 km E
Warbuton–Kalgoorlie 700 km SW
ii Tom Price–Fitzroy Crossing 900 km NE
Fitzroy Crossing–Halls Creek 200 km E
Halls Creek–Exmouth 1400 km SW
b Check with your teacher.

9 Port Moresby, NE ~150km to Popondetta, NW ~250 km to Lae, NW ~100km to Madang, SW ~170km to Mt Hagen, N ~250km to Wewak, NW ~250km to Vanimo, SE ~700km to Daru, E ~420km to Port Moresby.

Puzzle

Across
1. Distance
5. South
6. Kilometres
8. East
12. Millimetres
13. North
14. Approximate

Down
2. Systematic
3. Compass
4. Shortest
7. Scale
9. Metres
10. Error
11. West

Chapter checklist

1 8.75 m

2 **a** ~139 km **b** ~739 km

3 ~340 km Queenstown via Timaru to Christchurch

4 ~830 km Auckland to Hamilton to Napier to Gisborne to Rotarua to Auckland

5 **a** Queenstown, ~160 km
b Queenstown, ~180 km
c Nelson, ~100 km
d Napier, Gisborne, ~200 km and ~320 km

6 Dave hikes approximately 630 km from Queenstown, NE to Harihari, E to Christchurch and N to Nelson.

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Chapter review

1 **a** ~200 m **b** ~2.65 km
c ~2.5 km
2 $8
3 18 min
4 **a** ~1190 km
b ~1170 km
c The first route found in part **a** is short by about 20 km.
5 Approximately 4.7 km
6 **a** west ~3.23 km
b south-west ~2.9 km
c south-west ~1.7 km
7 Bert's class should walk north-west for approximately 1200 m, which should take about 12 min.

Chapter 12

Pre-test

1 **a** $3.33/kg **b** 56.5 L/min
c 3.11 m/h **d** 3.35 MB/s
e 10.44 m/s **f** 762.89 km/h
2 **a** 9.5 km/h
b 138.8 notes per min
c 26.33°C/min
d 630.43 km/h
e 1.47 m/year
f 1.00 rotation/day
3 **a** $0.0045/g or 0.45 cents/g
b $1124.87/week
c 8000 KB/s
d 45 calories/100 g
e 540 m/s
f $0.29/inch
4 **a** 902 000 m/h **b** 15 033 m/min
c 250.56 m/s
5 **a** 736.84 km/h vs 666.67 km/h → 7000 km in 9.5 h is quicker.
b 50 mm/min vs 45 mm/min → 15 cm in 3 min is quicker.
c 4.5 m/min vs 5.83 m/min → 2.1 km in 6 h is quicker.
6 A: $0.52/100 mL
B: $0.54/100 mL
C: $0.57/100 mL; therefore brand A is the cheapest.
7 **a** Fatima $1.25/apple, Reiko $1.125/apple; therefore, Reiko sells the cheapest apples.
b $2.50

Exercise 12A

1 **a** calories, kilojoules, (kJ)
b kilocalories, (kcal)
c ÷, 4.2, ×, 4.2
d kilojoules, 100 g, 100 ml
e more, consumed (or eaten)
2 **a** **i** 286 Cal **ii** 108 Cal
iii 18 Cal **iv** 235 Cal
b **i** 2293 kJ **ii** 244 kJ
iii 1319 kJ **iv** 764 kJ
3 **a** 6360 kJ, 1514 Cal
b 1914 kJ, 456 Cal
c 2670 kJ, 636 Cal
d 3050 kJ, 726 Cal
e 1128 Cal, 4738 kJ
f 1827 Cal, 7673 kJ
g 70 Cal, 294 kJ
h 4350 Cal, 18270 kJ
4 **a** 336 Cal **b** 132 Cal
c 490 Cal **d** 1658 Cal
e 155 Cal **f** 127 Cal
g 64 Cal **h** 903 Cal
i 211 Cal **j** 2729 Cal
5 **a** 1848 Cal **b** 73.92%
c 8.034 Cal/min **d** 230 min
6 **a** 1196 Cal **b** 59.8%
c 8.84 Cal/min **d** 135 min

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7 1530 Cal
8 248 Cal
9 Chocolate bar is 210 Cal; hiking burns all the energy in 30 min but cycling does not.
10 55 min
11 Answers will vary; total calories burned must exceed 1700 Cal.

Exercise 12B

1 **a** m/s, km/h **b** rate, time
c 1 unit
d **i** distance
ii distance, time, time
2 **a** km/h **b** km/h
c m/s **d** m/h
e km/year **f** km/year
3 **a** 10.4 m/s **b** 854.9 km/h
c 32 m/h **d** 18.7 km/h
e 2.1 m/s **f** 57.6 km/h
4 **a** 96 km/h **b** 32 km/h
c 190 km/h **d** 42.2 km/h
5 **a** 806.4 km/h
b 83.3 km/h
c 18.7 km/h
d 267.1 km/h
e 100.8 km/h
6 **a** 20.12 km/h **b** 141 km
c 7:20:04 **d** 19.22 km/h
7 cm/hour
8 57 km/h
9 90 km/h
10 3 m/s
11 56 km/h
12 Angus travelling at 112.9 km/h, therefore he risks a speeding fine, as the limit is 110 km/h.
13 Jade was approximately 1.33 m/s faster.
14 96 km/h

Exercise 12C

1 distance/time, $s = d/t$
distance/speed, $t = d/s$
speed × time, $d = s \times t$
2 **a** **i** 4 m/s **ii** 80 km/h
iii 7.3 m/s **iv** 88.4 km/h
b **i** 53.6 s **ii** 12.5 h
iii 7.0 h **iv** 29.5 s
c **i** 72 m **ii** 180 km
iii 520 km **iv** 175 m
3 1 h 40 min
4 233.75 km
5 83 km/h
6 16 m/s
7 Yes, he will, and by 10 seconds
8 38.3 minutes
9 150 km
10 90.7 km/h
11 5:30 p.m.
12 1465 km
13 1 p.m.
14 200 m race in 7.1 m/s, 800 m race in 6.8 m/s, so Boyce ran faster in the 200 m race.
15 9 km
16 485 km
17 40 m
18 3.7 min
19 **a** 105.5 km/h
b 18 min 38 s

Exercise 12D

1 **a** **i** Step 1: line, mm
ii Step 2: mm
iii Step 3: actual, map, mm, km/mm
b distance/speed, $t = d/s$
c hour, hours
2 **a** Scale is 13 mm, so the map scale is 15.4 km/mm

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b 37 mm, giving an actual distance of 570 km.
c 1.78 h = 1 h 47 min

3 **a** ~3.4 h **b** ~3.6 h **c** ~1.5 h
d ~1.5 h **e** ~4.8 h **f** ~4.9 h

4 **a** ~$12 400 **b** ~$18 000
c ~$9600 **d** ~$22 800
e ~$5400 **f** ~$5400

5 **a** ~$72 **b** ~$114 **c** ~$100
d ~$142 **e** ~$104 **f** ~$280

6 **a** ~750 km
b 2 a.m. the next day

7 **a** ~225 km **b** ~$131 400
c ~$262.80 each

8 ~1 h 55 min

9 ~5.45 p.m

10 Yes, Delia will make the delivery by 40 min.

11 ~$67 cheaper towing to Caboolture

12 ~$3180

13 5:40 p.m.

14 Any time after 11:30 a.m.

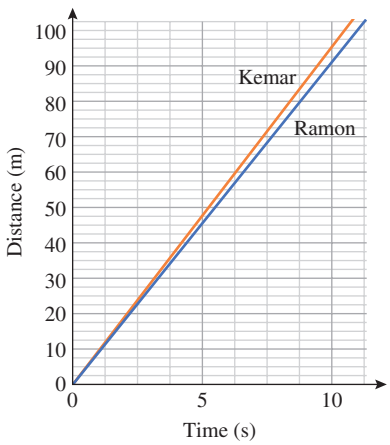
Exercise 12E

1 **a** vertical, horizontal
b (time, distance)
c straight, constant
d distance travelled, time taken
e zero
f faster
g **1**: distance **2**: time **3**: plot, segments

2 **a** A **b** B **c** C

3 **a** 6 km **b** 24 km/h
c 0 km **d** 0 km/h
e 2 km **f** 12 km/h

4

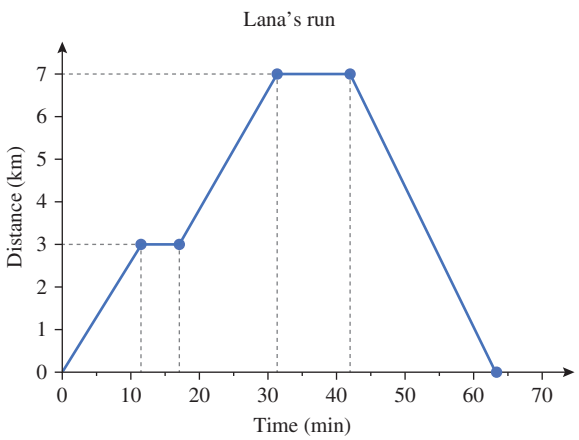


5 The hen walked 10 m in 20 s in the direction away from the coop. It stayed still for 20 s, then ran 30 m further away in 20 s, and then returned 40 m in 40 s to the coop.

6 **a** *C* to *D* **b** *B* to *C* **c** *D* to *E*

7 **a** D **b** A **c** C

8



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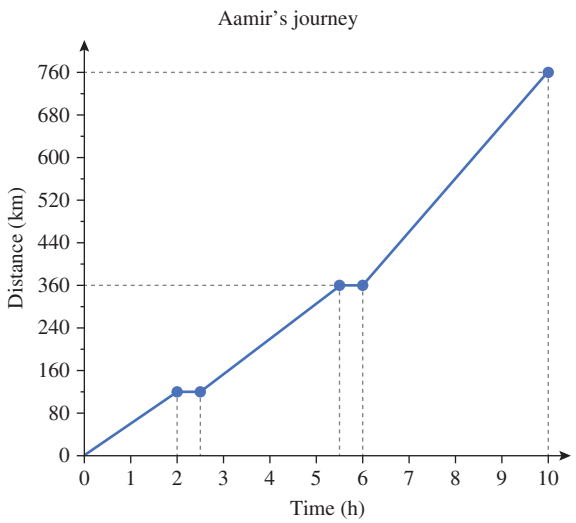
9



10 prototype X

11 Chen drove 200 km in 3 h and then stopped for an hour. He drove 300 km in the next 4 h and 100 km in the last 2 h.

12 Check with your teacher.

Puzzle

Koenigsegg Agera RS Sweden

Chapter checklist

1 5865 kJ

2 555 cal

3 m/s

4 0.53 m/s

5 72 km/h

6 962 m

7 4.25 h

8 5:30 p.m.

9 **a** ~4.2 h or 4 h 10 min

b ~$5184

10 **a** *AB* and *EF* **b** *BC*

c 1 m/s

Chapter review

1 1538.46 g

2 32.22 min

3 7:15 a.m.

4 2.5 m/s

5 89.29 km/h

6 6.9 km

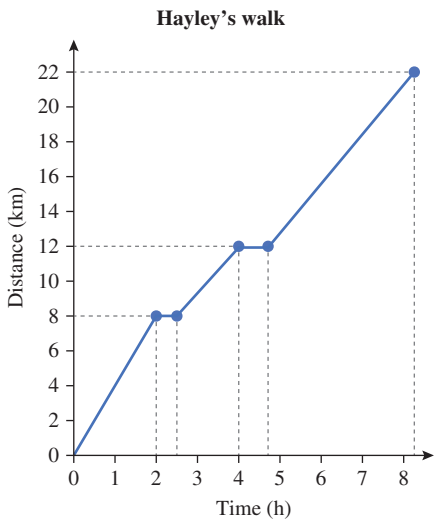
7 3:40 p.m.

8 12:04 p.m.

9 4.6 s

10 330 km

11



12 ~$9890

13 ~$370.91

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14 Dan walks 2 km slowly for 1 h and has a 30 min rest. He then walks another 2 km at 2 km/h for 1 h and rests for an hour before returning home at the same pace.

15 **a** 9:11 a.m.

b ~$10019.50

Chapter 13

Pre-test

1 **a** numerical; e.g. $2.50, $4.60

b categorical; e.g. garlic aioli, tomato

c numerical; e.g. 14, 41

d categorical; e.g. car, bike

e categorical; e.g. rock, pop

f numerical; e.g. 0, 4

2 **a** Wish to know canteen profits and change staffing and food choices accordingly.

b Fast-food restaurant might wish to know which sauces to have more stock of.

c Advertising company might wish to know which demographic to target.

d Government is planning future infrastructure based on preferred transport mode.

e A music store wishes to know what kind of music it should stock more of.

f A cinema wishing to know how many movies sessions they should have.

3 **a** Actual average is 10.2 but any estimates near 10 will suffice.

b Other 95 students might have completely different commute times.

c **i** average is 22.8; estimate is 20 – 25

ii The average has increased with new responses.

d Yes, would be better as there are more people responding, which means a better estimate of all students' commute times can be done.

e group in 5s; teacher to check dot plot.

4 **a**

Range	Frequency
71–75	1
76–80	1
81–85	3
86–90	1
91–95	3
96–100	1
Total	10

b They are unlikely to participate as they might be embarrassed about their lower score and not wish others to know.

c This survey's participants might only have those students who wish to show their test score, as students with poor scores would prefer not to participate. This would result in the data appearing to show that students have a generally high score, when it may not be the case.

5 **a** numerical data

b lowest 109, highest 205

c Average is 136; any estimate between 125 and 145 is acceptable.

d Data should be grouped. Histograms, dot plots, tables or stem-and-leaf plots can be used. Check with your teacher.

e Outliers are 205 and 195. Answers may vary. For example: There could be a special event (e.g. concert, gala, store opening) happening on that day, resulting in a higher number of commuters.

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f Answers may vary. Must mention that people go to work on weekdays, whereas on weekends most people will relax and might not use trains, making it difficult to estimate.

Exercise 13A

1 **a** entire
b number, plan
c funds, services

2 **a** **i** The data can be used for electoral purposes to group population into electorates with similar characteristics (e.g. families or no families) or when campaigning to the majority with the hope of winning an election.
ii The data can be used when assigning government funding to decide which target population it should allocate the most funding to or to decide what schemes/infrastructure should be given funding to support the general population.
b The government could use the information to determine how much money it needs to assign to childcare services, as well as to plan for future superannuation policies for both working parents.

3 The Australian Bureau of Statistics (ABS) organises the census. They send out paper forms, but it can also be completed online. The census is completed by everyone every 5 years, and everyone completes it on the same day. It works by sampling everyone who is present at the house on that night to get an idea of the current housing and population of Australia. Many things are asked about like age, gender, work and so on.

4 The **disadvantages of a Census might include**: might be difficult to enumerate (count) all units of the population within the available time; higher costs, both in staff and monetary terms, than those required for a sample; generally takes longer to collect, process, and release data than from a sample
The **advantages of a Census** include: provides a true measure of the population (no sampling error); benchmark data may be obtained for future studies; detailed information about small sub-groups within the population is more likely to be available.

5 **a** Many students pay for their tertiary studies through HECS, which they have deducted from their income once they start earning a certain amount. Government needs to ensure that tertiary graduate students will end up in the workforce and repaying their debts, so it will encourage tertiary institutions to offer places in courses that will lead to high employability of graduates.
b From that statistic, the government can delve more into why fewer women than men are employed; e.g. taking leave to take care of children or pregnancy. Then it can begin planning to tackle those issues and help more women into the workforce.
c People with non-school qualifications will usually have more skills to offer, enabling them to have more technical and professional jobs that pay higher incomes. If there is clear evidence that having a qualification results in a higher income, the

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government has more incentive to give people more opportunities to undertake courses to obtain a qualification.

d Aboriginals and Torres Strait Islanders often live in rural areas, making it particularly hard to access many services and facilities, such as schools and hospitals. Knowing that many young people are having difficulty accessing education, the government can assign funding and promote programs to assist young people access these services.

6 a questions 13 and 44

b immigration

c To be able to accurately describe the cultural diversity of the Australian population

d To determine how many people speak English as a second language

e To ensure that services are able to be provided to cater to non-English speaking Australians

f Some people are private about their religion

g To determine how many people require assistance with self-care, mobility and communication

h Some people need help with everyday activities. This can mean a family member might be unable to work full-time and might need monetary assistance. The government needs to plan for the funding of such services and programs.

i employment

j By keeping track of which sectors are employing people, the government can use this information when promoting jobs and industries.

k To determine how people travel to work

l Rail, bus and road networks are all planned by governments. It is important to track how these services are being used and compare changes to previous censuses.

Exercise 13B

1 a count

b information, sample

c data, characteristics

d equal

e wants

2 a Census is better because you want to count the total number of new houses built.

b Survey is better because you want information from a population; that is, whether participants like the Prime Minister

c Survey is better because you want to find out the population's preferences.

d Census is better because you want a total count of views.

3 a census **b** survey

c survey **d** census

4 a Jasper, Lúc, Charné, Steven, William, William, Liam, Andrew, Connor, Mark

b i 49 boys in the year group

ii $\frac{49}{70}$ or $\frac{7}{10}$

c i nine boys in the sample

ii $\frac{9}{10}$

d This is not a suitable sample. The proportion of boys in the sample is greater than the proportion in the population.

5 a Alexander, Andrew, Courtney, Jake, Clayton, Molly, Oliver, Jarrod, Jasper, Rhys

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b **i** 49 boys in the year group

ii $\frac{49}{70}$ or $\frac{7}{10}$

c **i** eight boys in the sample

ii $\frac{8}{10}$

d This is not a suitable sample. The proportion of boys in the sample does not match the proportion in the population.

e Random sampling is fair and generally gives a good representative sample; however, it could be difficult in identifying all population members and resulting in the possibility of a skewed sample.

6 **a** William, Jarrod, James, Caleb, Connor, Amy, Lúc, Thomas, Jack, Molly, Cassius, Alakiir, Bonnie, Mark, Ryan, Oliver, Damian, Liam, Courtney, Chloe

b **i** 49 boys in the year group

ii $\frac{49}{70}$ or $\frac{7}{10}$

c **i** 14 boys in the sample

ii $\frac{14}{20} = \frac{7}{10}$

d This is a suitable sample. The proportion of boys in the sample matches the proportion in the population.

7 **a** Cricket fans who are willing to pay the cost to enter will participate in the survey.

b A single prize of $2000 plus $50 worth of KFC.

c Only those people who are willing to pay the 55 c entry cost will participate. Multiple votes means people could enhance their chance of winning by voting more often and, therefore, possibly affecting the results.

d This is not a reliable survey method as not all cricket fans have the ability to participate.

e The advantages of self-selected surveys are very easy to conduct, and participants wish to be involved. However, the disadvantages are that the results can be biased because people can vote multiple times, and only those people who are particularly interested will participate.

8 **a** self-selected survey

b The data is not reliable. There would be a lot of good feeling about Smith at the time, and some of the other players on the list might be unknown to some participants due to their age.

Exercise 13C

1 **a** regular **b** divide **c** random

2 **a** 30

b 15

c 16

d 3

e 18

3 Advantages of a systematic random sample include: very easy to conduct; and the population is evenly sampled. Disadvantages of a systematic random sample include: Can be biased if the sample is not taken from a complete list of the population; and can adversely affect results if some trait of the population coincides with the frequency of selection (e.g. every 12th item manufactured is a defect).

4 **a** Not all Australian adults are on the electoral roll, as they might be new to the country.

b Not all teenagers will be at school in Year 11 or 12; some may have dropped out or graduated.

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5 a $\frac{70}{10} = 7$

b

1 Ellie	11 Brenda	21 Bonnie	31 Jack	41 Thomas	51 Brent	61 Jennifer
2 Erica	12 James	22 Will	32 Rhys	42 Cassius	52 William	62 Jessica
3 Connor	13 Damian	23 Ned	33 Nicholas	43 Caleb	53 Dale	63 Oliver
4 James	14 Molly	24 Christopher	34 John	44 Matthew	54 Jake	64 Hamish
5 Mark	15 Steven	25 Liam	35 Michael	45 Jack	55 Caitlin	65 Henry
6 Thomas	16 Alexander	26 Courtney	36 Reid	46 Eamon	56 Charles	66 Katelyn
7 Tennelle	17 Chloe	27 Ryan	37 Alakiir	47 Meg	57 Lúc	67 Kobi
8 Samuel	18 Dominic	28 Charné	38 Angelo	48 Christopher	58 William	68 Jarrod
9 Amy	19 Thomas	29 Jacob	39 Jasper	49 Thomas	59 Clayton	69 Jack
10 Andrew	20 Kristen	30 Olivia	40 Breanna	50 Mark	60 Emma	70 Alexander

c Girls (population) $= \frac{21}{70} = \frac{3}{10}$ Girls (sample) $= \frac{1}{10}$

The sample and population are not in the same proportions.

d The method has not produced a sample that reflects the population this time. Using this sample could produce biased results.

e i

1 Ellie	11 Brenda	21 Bonnie	31 Jack	41 Thomas	51 Brent	61 Jennifer
2 Erica	12 James	22 Will	32 Rhys	42 Cassius	52 William	62 Jessica
3 Connor	13 Damian	23 Ned	33 Nicholas	43 Caleb	53 Dale	63 Oliver
4 James	14 Molly	24 Christopher	34 John	44 Matthew	54 Jake	64 Hamish
5 Mark	15 Steven	25 Liam	35 Michael	45 Jack	55 Caitlin	65 Henry
6 Thomas	16 Alexander	26 Courtney	36 Reid	46 Eamon	56 Charles	66 Katelyn
7 Tennelle	17 Chloe	27 Ryan	37 Alakiir	47 Meg	57 Lúc	67 Kobi
8 Samuel	18 Dominic	28 Charné	38 Angelo	48 Christopher	58 William	68 Jarrod
9 Amy	19 Thomas	29 Jacob	39 Jasper	49 Thomas	59 Clayton	69 Jack
10 Andrew	20 Kristen	30 Olivia	40 Breanna	50 Mark	60 Emma	70 Alexander

ii Girls (population) $= \frac{21}{70} = \frac{3}{10}$ Girls (sample) $= \frac{3}{10}$

Therefore, same mix in sample as in population.

iii This has been a suitable method for selecting a sample.

f i $\frac{70}{20} = 3.5$; therefore, we will pick every fourth name until we have the required sample size.

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ii

1 Ellie	11 Brenda	21 Bonnie	31 Jack	41 Thomas	51 Brent	61 Jennifer
2 Erica	12 James	22 Will	32 Rhys	42 Cassius	52 William	62 Jessica
3 Connor	13 Damian	23 Ned	33 Nicholas	43 Caleb	53 Dale	63 Oliver
4 James	14 Molly	24 Christopher	34 John	44 Matthew	54 Jake	64 Hamish
5 Mark	15 Steven	25 Liam	35 Michael	45 Jack	55 Caitlin	65 Henry
6 Thomas	16 Alexander	26 Courtney	36 Reid	46 Eamon	56 Charles	66 Katelyn
7 Tennelle	17 Chloe	27 Ryan	37 Alakiir	47 Meg	57 Lúc	67 Kobi
8 Samuel	18 Dominic	28 Charné	38 Angelo	48 Christopher	58 William	68 Jarrod
9 Amy	19 Thomas	29 Jacob	39 Jasper	49 Thomas	59 Clayton	69 Jack
10 Andrew	20 Kristen	30 Olivia	40 Breanna	50 Mark	60 Emma	70 Alexander

iii Girls (population) $= \frac{21}{70} = \frac{3}{10} = \frac{6}{20}$

Girls (sample) $= \frac{5}{20} = \frac{2.5}{10}$

Although not the same proportions exactly, this sample is a reasonable reflection of the population.

iv This method has been suitable in selecting a sample that has characteristics similar to the population it is drawn from.

g A systematic sample does not always produce a sample that has the same characteristics as the population it is drawn from. Sample size and where you begin can result in a different outcome. Care must be taken to ensure that the sample is consistent with the population.

Exercise 13D

1 **a** characteristics
b proportions, groups
c fraction, percentage

2 **a** 9
b 24
c 3
d 15

3 An advantage of a stratified sample is that it has the same characteristics as the population. A disadvantage is it can be more time consuming to determine the sample.

4 **a** 60 casual employees
b 29 employees
c **i** 10 full-time
ii 7 part-time
iii 12 casual

5 **a** Total sample $= \frac{15}{100} \times 92 = 13.8 \approx 14$ students

b Girls $= \frac{40}{92} \times 14 \approx 6$

c Boys $= \frac{52}{92} \times 14 \approx 8$

d Girls

1 Gabrielle	11 Mia	21 Julia	31 Emily
2 Amy	12 Gabriella	22 Ellie	32 Gabrielle
3 Molly	13 Claudine	23 Erica	33 Tara
4 Bonnie	14 Isabella	24 Tennelle	34 Heidi
5 Courtney	15 Keely	25 Brenda	35 Georgia
6 Breanna	16 Claire	26 Chloe	36 Meg
7 Caitlin	17 Caitlin	27 Kristen	37 Cassie
8 Emma	18 Katelyn	28 Meg	38 Shania
9 Jessica	19 Caitlyn	29 Jennifer	39 Nikita
10 Ruby	20 Kate	30 Bonnie	40 Codey

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e Boys

1 Christopher	11 Sean	21 William	31 Matthew	42 Thomas
2 Thomas	12 Braden	22 Jake	32 Elliot	43 Will
3 Andrew	13 Mark	23 Charles	33 Matthew	44 Ned
4 Jacob	14 James	24 Oliver	34 Thomas	45 Jack
5 John	15 Christopher	25 Henry	35 Connor	46 Rhys
6 Alexander	16 Liam	26 Jack	36 James	47 Nicholas
7 Benjamin	17 Ryan	27 Jack	37 Samuel	48 Michael
8 William	18 Matthew	28 Matthew	38 Damian	49 Angelo
9 Seamus	19 Thomas	29 Riley	39 Steven	50 Jasper
10 Thomas	20 Brent	30 Thomas	40 Alexander	51 Caleb
			41 Dominic	52 Jack

6 a 36 students

b i Day girls $= \frac{55}{180} \times 36 = 11$

ii Boarder girls $= \frac{23}{180} \times 36 = 4.6 \approx 5$

iii Day boys $= \frac{65}{180} \times 36 = 13$

iv Boarder boys $= \frac{37}{180} \times 36 = 7.4 \approx 7$

7 a

State	'000s	Senate seats	
NSW	7861.10	24.28741	24
Vic.	6323.60	19.5372	20
Qld	4928.50	15.22694	15
SA	1723.50	5.324872	5
WA	2580.40	7.972324	8
Tas.	520.90	1.609357	2
NT	246.10	0.760343	1
ACT	410.30	1.26765	1
Australia	**24 598.90**	75.98610	76

b NSW, Qld and Vic. would be entitled to more Senators if population were to be used to determine the composition of the Senate. SA, WA, Tas., NT and ACT all would have less representation in the Senate if population size were to determine the composition of the Senate.

Exercise 13E

1 a entire **b** sample
c agree **d** accurate

2 A and iv, B and i, C and iii, D and ii

3 B

4 A

5 a D

b To ensure that the conclusion is not biased and takes into account everyone in the school.

6 a C

b They wish to know if all, not just a few, employees would like free access to the gym.

7 a Everyone taking boat trips to see the Great Barrier Reef

b To ensure that the conclusion is accurate, so that the satisfaction results comes only from those people who actually went on the boat trip.

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8 all of the grower's plants
9 all items leaving the factory
10 all the employees of the factory
11 all voters

Exercise 13F

1 a technical, 20
b meaning, clear
c number, fatigue
d privacy, shared
e bias, leading

2 a There are only two options; many people don't fit into the two options provided in the survey.
b There are too many options; can cause survey fatigue and people are more likely to remember only the two extreme options.
c Less than 1 hour, 1–2 hours, 3–4 hours, 5 or more hours

3 a Yes; a question should have fewer than 20 words.
b It is a double-barrelled question. First question: Does it seem possible or impossible that NSW will win the State of Origin. Second question: Do you feel they will always find a way to lose?
c It contains bias. It implies NSW will always find a way to lose the State of Origin.
d 'Do you think NSW has a chance of winning the State of Origin?'

4 a standardised
b The middle two sentences offer opinion and can be deleted.
c 'Students must take standardised NAPLAN tests in reading, writing, and mathematics. Do you think that your students take too many standardised tests?'

5 a It is unclear what type of shopping is being done.
b Where do you like to do your grocery shopping?
c Which online shop do you like to make purchases?
d Where do you like to buy your runners?

6 a Question does not set a time frame.
b Where were you born?
c Where did you spend the majority of your time this morning?

7 a bias **b** bias
c bias **d** bias

8 a '…avoid a catastrophic invasion…' puts bias in the question. Rewrite as: 'Do you think the government should spend more on the military?'
b '…good' adds bias. Rewrite as: 'What do you think of the new policy?'.
c '…new recipe better than the old recipe' adds bias. Rewrite as: 'What do you think of the new recipe?'
d There is no bias in the question but question could be rewritten to make it easier to understand, Rewrite as: 'Do you think students should be allowed to use mobile phones at school?
e Opening statement '…employees love their jobs' adds bias. Rewrite as: 'How do you feel about your job with the Government?

9 a i It is not clear that the survey is about sport at school.
ii On how many occasions do you participate in sport and physical activity at or with school in a week?
iii They are not accommodated
iv They are not accommodated
v Revised options:
- ☐ 0
- ☐ 1–2
- ☐ 3–4
- ☐ 5–6
- ☐ More often

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b Samples could include:
- ☐ Netball
- ☐ Rugby
- ☐ Soccer
- ☐ Swimming
- ☐ Athletics
- ☐ Volleyball
- ☐ Touch

c Answers will vary:
- ☐ Before school
- ☐ After school
- ☐ Weekends
- ☐ Lunch breaks

d i The use of 'limited' implies that not enough sports options are offered.

ii Do you think the sports options available at school are reasonable?

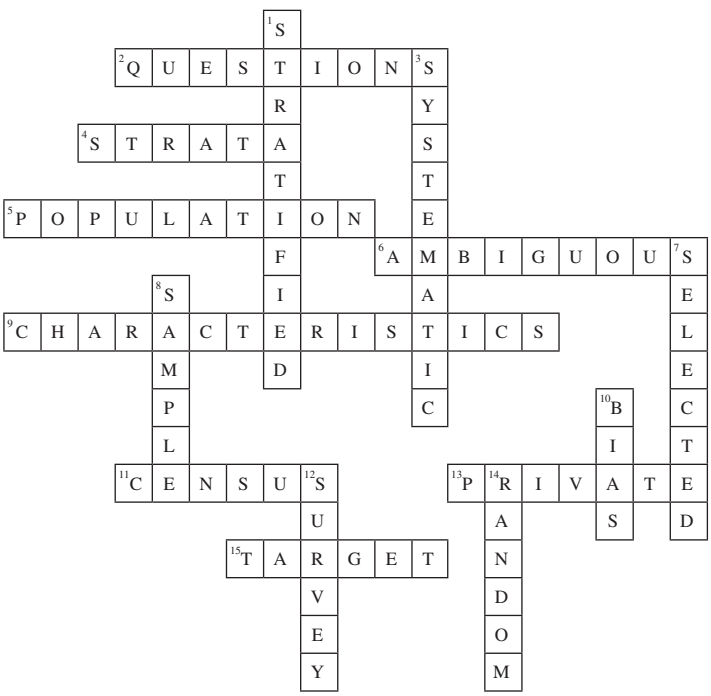
e i The question is biased by offering an opinion before the question.

ii Do you think the school should offer more sports? If so, what sports should they offer?

f i No, there is no need to collect participants' date of birth or name.

ii The survey responses are not secure outside the Sports Staffroom and someone could access them who is not authorised to do so.

Puzzle



Chapter checklist

1 a A census is an official count of an *entire* population.

b All members of the population complete the census at the same time.

2 a Advantages of a census: provides a true measure of the population (i.e. no sampling error); benchmark data may be obtained for future studies; and detailed information about small subgroups within the population is more likely to be available.

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b Disadvantages of a census: may be difficult to enumerate (i.e. count all units of the population within the available time); higher costs, both in staff and monetary terms, than for a sample; and generally takes longer to collect, process, and release data than from a sample.

3 a A survey is the process of gathering information from a small group (i.e. sample) from within a population.

b Advantages of a survey are: costs would generally be lower than for a census; results may be available in less time; and if good sampling techniques are used, the results can be very representative of the actual population.

c Disadvantages of a survey are: data may not be representative of the total population, particularly when the sample size is small; since data is collected from a subset of units and inferences are made about the whole population, the data is subject to 'sampling' error; and decreased number of units will reduce the detailed information available about subgroups within a population.

4 The purpose of sampling is to gather data about the population. Information from the sample is used to estimate the characteristics of the population, without the need to survey the entire population.

5 a Members are selected from a numbered list using random numbers until the desired sample size is achieved.

b Advantages include: easy to conduct, high chance of achieving a good representative sample.

c Disadvantages include: identifying all members of the population can be difficult, contacting members of the sample can be difficult.

6 a A self-selected sample is a sample comprising participants willing to answer the survey's questions.

b Advantages include: very easy to conduct and participants are willing to be involved.

c Disadvantage is that it can be very biased as people can vote multiple times.

7 a A systematic sample is made by selecting subjects from a list at regular intervals.

b Advantages include: very easy to conduct and the population is evenly sampled.

c Disadvantage is the possibility that some other trait of the population coincides with the frequency of selection, creating a biased sample.

d $\frac{500}{20} = 25$th student

8 a To achieve the same characteristics and proportions as those in the sample, the population is divided up into groups, called strata. The proportions of these groups are calculated, generally as a fraction or a percentage, and applied to the sample.

b An advantage is that it has the same characteristics as the population.

c A disadvantage is it can be more time consuming to determine the sample.

9 a Target population refers to the entire group of individuals you are interested in including in your survey.

b Sample population is the group of individuals asked to participate in your survey.

c Study population is the final group of people who agree to be involved in your survey.

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10 a To use simple language means to not use jargon or technical words in the survey questions that respondents may not understand.

b Ambiguous questions are not clear in what they mean.

c Asking lots of questions or having lots of options to choose from when answering a question can lead to survey fatigue in the sample group.

d The information collected during a survey needs to be kept confidential/private and not shared with unauthorised people, as people may not want their information to be shared.

e Bias is when questions lead the respondent to the same answer.

Chapter review

1 A and v, B and vii, C and ii, D and vi, E and iv, F and viii, G and iii, H and ix, I and i.

2 a self-selecting **b** systematic

c random **d** stratified

3 a census **b** survey **c** census

d census **e** census **f** survey

4 a 23 **b** 9 **c** 15

5 a

1 Abigail	11 Aria	21 Chloe	31 Ethan	41 Jacob	51 Lily	61 Noah	71 Scarlett
2 Addison	12 Aubrey	22 Christopher	32 Evelyn	42 James	52 Logan	62 Nora	72 Sebastian
3 Aiden	13 Audrey	23 Daniel	33 Gabriel	43 Jayden	53 Lucas	63 Oliver	73 Skylar
4 Alexa	14 Ava	24 David	34 Grace	44 John	54 Luke	64 Olivia	74 Sofia
5 Alexander	15 Avery	25 Dylan	35 Hannah	45 Joseph	55 Madison	65 Paisley	75 Sophia
6 Allison	16 Benjamin	26 Elijah	36 Harper	46 Joshua	56 Mason	66 Penelope	76 Victoria
7 Amelia	17 Brooklyn	27 Elizabeth	37 Henry	47 Layla	57 Matthew	67 Riley	77 William
8 Andrew	18 Camila	28 Ella	38 Isaac	48 Leah	58 Mia	68 Samantha	78 Wyatt
9 Anna	19 Carter	29 Emily	39 Isabella	49 Liam	59 Michael	69 Samuel	79 Zoe
10 Anthony	20 Charlotte	30 Emma	40 Jackson	50 Lillian	60 Natalie	70 Savannah	80 Zoey

b $\frac{35}{80} = 0.438$

c $\frac{9}{15} = 0.6$

d There is an over-representation of boys in the sample. There should be approximately $\frac{35}{80} \times 15 = 6.6$ boys in the sample.

6 a $\frac{80}{15} = 5.333$, so every fifth child on the list.

b

1 Abigail	11 Aria	21 Chloe	31 Ethan	41 Jacob	51 Lily	61 Noah	71 Scarlett
2 Addison	12 Aubrey	22 Christopher	32 Evelyn	42 James	52 Logan	62 Nora	72 Sebastian
3 Aiden	13 Audrey	23 Daniel	33 Gabriel	43 Jayden	53 Lucas	63 Oliver	73 Skylar

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4 Alexa	14 Ava	24 David	34 Grace	44 John	54 Luke	64 Olivia	74 Sofia
5 Alexander	15 Avery	25 Dylan	35 Hannah	45 Joseph	55 Madison	65 Paisley	75 Sophia
6 Allison	16 Benjamin	26 Elijah	36 Harper	46 Joshua	56 Mason	66 Penelope	76 Victoria
7 Amelia	17 Brooklyn	27 Elizabeth	37 Henry	47 Layla	57 Matthew	67 Riley	77 William
8 Andrew	18 Camila	28 Ella	38 Isaac	48 Leah	58 Mia	68 Samantha	78 Wyatt
9 Anna	19 Carter	29 Emily	39 Isabella	49 Liam	59 Michael	69 Samuel	79 Zoe
10 Anthony	20 Charlotte	30 Emma	40 Jackson	50 Lillian	60 Natalie	70 Savannah	80 Zoey

c $\frac{9}{15} = 0.6$

d There is an over-representation of boys in the sample. There should be approximately $\frac{35}{80} \times 15 = 6.6$ boys in the sample.

7 a $\frac{35}{80} = 0.438$

b $\frac{35}{80} \times 15 = 6.5625$, which rounds up to seven boys.

c Use the first seven random numbers without repeating.

1 Aiden	11 Elijah	21 Joseph	31 Oliver	6 Anna	16 Elizabeth	26 Leah	36 Riley
2 Alexander	12 Ethan	22 Joshua	32 Samuel	7 Aria	17 Ella	27 Lillian	37 Samantha
3 Andrew	13 Gabriel	23 Liam	33 Sebastian	8 Aubrey	18 Emily	28 Lily	38 Savannah
4 Anthony	14 Henry	24 Logan	34 William	9 Audrey	19 Emma	29 Madison	39 Scarlett
5 Benjamin	15 Isaac	25 Lucas	35 Wyatt	10 Ava	20 Evelyn	30 Mia	40 Skylar
6 Carter	16 Jackson	26 Luke	1 Abigail	11 Avery	21 Grace	31 Natalie	41 Sofia
7 Christopher	17 Jacob	27 Mason	2 Addison	12 Brooklyn	22 Hannah	32 Nora	42 Sophia
8 Daniel	18 James	28 Matthew	3 Alexa	13 Camila	23 Harper	33 Olivia	43 Victoria
9 David	19 Jayden	29 Michael	4 Allison	14 Charlotte	24 Isabella	34 Paisley	44 Zoe
10 Dylan	20 John	30 Noah	5 Amelia	15 Chloe	25 Layla	35 Penelope	45 Zoey

d $\frac{45}{80} = 0.563$

e $\frac{45}{80} \times 15 = 8.437$, which rounds down to eight girls.

f As identified in part **c**.

8 The stratified sample is the only sample that has the same proportions of boys and girls attending the day care centre.

9 All the families who attend the day care centre.

10 a i too long

ii sensory, cognitive

iii There is no scale for how happy the parents are. Some parents may be happy with 1 h of outside play and others may like 5 h.

iv On a scale of 1–5, how happy are you with the amount of outside play your child participates in while at the day care centre?

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Not happy 1	2	3	4	*Very happy* 5

b i There are too many choices.

ii Laser skirmish and contact sports like touch football are not appropriate.

iii Revised list:

- ☐ Bikes
- ☐ Painting
- ☐ Sandpit
- ☐ Monkey bars
- ☐ Swings
- ☐ Obstacle course
- ☐ Other

c i not relevant or reasonable

ii not relevant or reasonable

iii Information relating to survey questions 6 & 7 are a private matter for the families and have nothing to do with the day care centre or the purpose of the survey.

iv not ethical

v not relevant and not needed in the survey

d If no-one is at the reception, the response sheets could be easily accessed by someone who is not authorised to see the information.

Chapter 14

Pre-test

1 a Anita's main target population would be the students and teachers.

b A census is a count of the *entire* population. It is impractical as Anita would literally have to ask every single person in the school.

c i Does not properly represent the rest of the school such as other year groups.

ii Systematic survey so may be slightly biased. Only those who use the facility are asked so does not represent the *entire* school.

iii Self-selected survey, which means only those who know about the survey and have a strong opinion on the facility will talk about it.

iv Randomised survey, so may be skewed and inaccurate. Identifying and contacting members can be difficult.

v Administrative staff are not the target population at all.

vi Stratified samples are more time consuming to determine.

d i 'Usually' is ambiguous.

ii Question is biased because it leads the respondent to a particular answer.

iii Too lengthy and needlessly wordy. 'Amenities in the sports facility' will suffice.

iv Disregards people who don't have an opinion or are ambivalent.

v There are no problems with this question.

2 a 60% prefers brand Red, 40% prefers brand Blue.

b The axis begins at 30%, which makes it appear that brand Red is three times more popular than brand Blue, when in reality the difference is not that big. Colour is also an issue, as people will be drawn to the bright red colour compared with the dark blue.

3 a Although the question wishes to know the overall political preference of the electorate, it is concerned only with whether participants like a certain political party. Also, there is some bias in using 'like' with 'party A'.

b The results only consider people above 60 years old, which means the sample is unrepresentative. % is also used in the results.

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c Gabriel would conclude that people's opinion of political party A is characterised by age, when actually the amount of people who like party A and dislike party A are roughly the same.

d Gabriel asked a total of only 20 people, which means the results may be inaccurate. He also ignored those aged between 30 and 60 years, making the sample very unrepresentative of the electorate.

Exercise 14A

1 a difference

b i same **ii** positive **iii** possibility

c sampling **d** accurate, consistent

2 a i People at Broncos game will prefer NRL over other sports.

ii Asking people outside a sports store.

b i People near the store will prefer it over other fast-food outlets in the food court.

ii Stand near the entrance to the food court to ask people entering/leaving the food court.

c i People affected by any changes will have strong feelings for or against. It is better to have a wider selection of the population included in the survey.

ii Survey people in a shopping centre or by a phone poll etc.

d i Likely sample will not have full-time jobs since survey is being conducted at a time when most working people would be at work.

ii Survey people by phone.

e i Parents will have different preferences in music from those of their children/students attending the dance.

ii Ask students about what type(s) of music to be played at the dance.

f i The sample is too small.

ii Increase the size of the sample.

g i The sample is not representative of the entire population

ii Ask people in all States and Territories.

3 a Processing fault: mistake

b Measurement fault: variability in thickness of soles makes it difficult to be accurate.

c Start measuring from a different starting point (e.g. 10 cm) to avoid a measurement fault.

d Measurement error: systematic error

e Measurement error: systematic error

4 a D

b A rejected because the question does not collect the information required, as it is limited to yes/no responses.
B and C rejected because there is no possibility of giving a particular response such as 'none'. Also, there is no way of indicating a favourite sport.

5 a What do you think of the use of phones by students at school?

b What do you think the influence of social media is on people's socialness?

c Do you prefer to visit the beach or cities?

d Do you think that we should have a sugar tax on soft drinks?

6 a The poll is a self-selecting poll that is limited to those people who read the news website. Having the poll at the end of the article might bias people's previously held beliefs about the issue.

b A phone poll of random people might give a more balanced response rate.

7 a 89 000

b 83%

c self-selecting sample

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8 **a** 1800
b 26%
c Possibly a self-selecting survey since it was posted on social media.
d Differences might be due to different sample size or demographics of participants, whereby an internet poll is likely to have lots of younger participants who use social media frequently and the marketing group poll is likely to have older participants.

9 **a** 46.5 g
b 47.4 g
c 46.7 g, 47.3 g, 47.0 g

10 **a** 74 mm **b** 7 cm
c 4 mm **d** 5.41%

11 **a** Patrick is not accurate or precise. It is likely that the correct mass is around 23.15 grams.
b Craig is most consistent. There is little variation between his measurements although they are a lot different from the trials of the other students, indicating that Craig's accuracy is likely to be very low.
c Harry is accurate and consistent.

Exercise 14B

1 **a** applied, bias
b interviewer, questionnaire, errors
c assume, coincidence, backwards, outside

2 **a** Only 46% of customers responded and they are likely to be customers who are happy with the company. Unhappy customers may not have replied, thus resulting in non-response bias.
b The question is biased in that neutral or negative responses are not possible.
c Less than half the customers responded to the survey, which allowed only positive feedback to be given. It could be that the customers who did not respond are not happy with the service.

3 **a** self-selecting survey
b Only people who follow the online newsagency will have voted in the poll. The sample is not representative of the entire population.

4 **a** The sample is not representative of the entire student body. It is likely that only those students who like the canteen food were invited to participate.
b By ignoring the opinions of students who do not use the canteen, changes that might need to be made to the menu are not made.

5 **a** There is interviewer bias in the question. This can influence the participant's response.
b Lachlan should remove any reference to which team is his favourite.

6 **a** This is a processing error.
b The average number of hours completed will be increased by the incorrect entry.

7 **a** Jeff needs to be wary of small changes and whether they can be applied to a longer time period.
b The share price has generally fallen over the 3 month period. It is not a good investment at this time.

8 **a** You need to ignore coincidence.
b You could assume that eating more cheese increases your chances of dying by becoming tangled in your bed sheets!

9 **a** It is suggesting that working lowers your risk of mental illness. The cause and effect might be the other way around.
b A; People with mental illness are likely to have difficulty maintaining employment.
c Proportion of population by employment status at risk of mental health illness

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10 **a** It is implying a cause and effect but it is likely to be an outside cause that is influencing both sets of data.

b Advancements in science and medicine have made organic foods more accessible and increased the awareness and diagnosis of autism.

11 **a** Outside causes have been ignored.

b Home life, intellectual stimulation (e.g. parent reading to the child) and bonding between mother and child are overlooked as possible causes of success.

c The report could add undue pressure and stress to a mother who is unable to breastfeed for various reasons.

Exercise 14C

1 **a** misrepresented, impression

b misleading

c data, mislead

d incorrect

e small, large

f percentages

2 **a** **i** 0.6 million

ii ≤ 1.0 million

iii 1.1 million

iv The wrong inequality sign has been used. This reads as 'less than 1 million'.

b **i** 0.25 million

ii 1.12%

c **i** 0.6 million

ii 2.50%

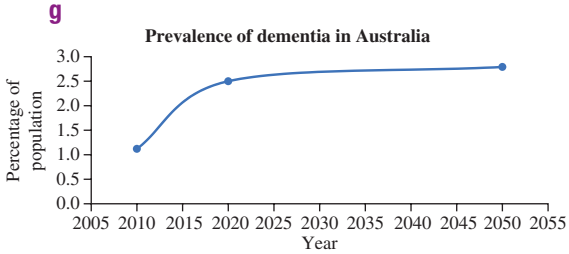
d **i** 1.0 million

ii 2.79%

e People are living longer because of better treatment of other causes of death (e.g. cancer or heart disease etc.). As the population will grow between 2010 and 2050, so will the number of people with dementia naturally increase also.

f The horizontal axis does not have an even scale. The vertical axis should be a percentage of population. Having the line cross over a map of Australia might give the impression that almost the entire Australian population will have dementia by 2050.

g



3 **a** **i** 15.75 c

ii 47.13 c

iii 35.69 c

b **i** 2.99 : 1

ii 2.27 : 1

c The claim is valid; both ratios are between 2 and 3.

d **i** US 7 mm

ii SA 47 mm

iii Qld 32 mm

e **i** 6.71 : 1

ii 4.57 : 1

f **i** The ratios in part **e** are much higher.

ii The prices and the ratios stated are consistent with each other. The graph is not consistent with either.

iii To emphasise the high prices in Australia

g **i** Small samples are less reliable.

ii High/low pieces of data will affect the average.

iii Cities could be more expensive than areas closer to power stations etc.

iv Different forms of energy have different costs. There is no indication if this was considered.

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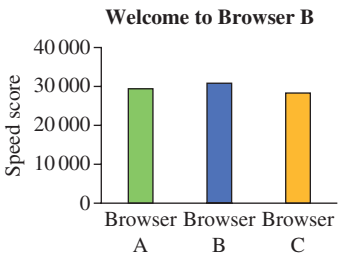
4 a The Council has omitted data that did not suit its needs (e.g. the 2014–2016 and 2017 data).

b To give the impression of a booming economy in the region and to attract new investment.

5 a Gauge is bigger for Browser B. The meters do not start at zero.

b



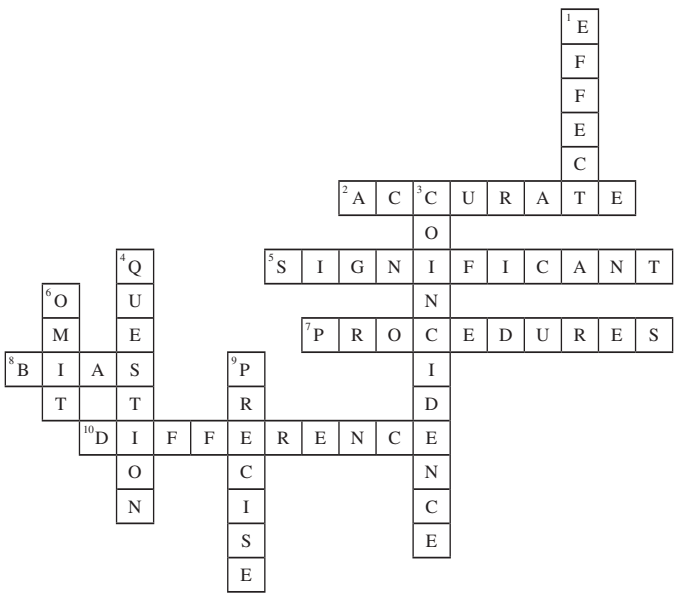
c i 4.6%

ii 8.22%

d There is no indication of sample size. It might be a very small sample.

e There is no indication of how the results were calculated. An average result would be affected by high and/or low data, whereas a median not so much.

Puzzle



Chapter checklist

1 a People can vote more than once; only people with access to the internet can participate; people with strong views are more likely to participate and encourage others to do the same; self- selecting sample.

b Conduct a phone poll that covers all demographics in the community.

2 a Only viewers with Facebook access can participate. Less likely to have older viewers participate.

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b Phone poll; survey people that attend a live show.

3 Systematic error; all results will be wrong by the same amount.

4 **a** Self-selecting survey; only people who wished to participate in the survey. Since poll is online, the participants are more likely to be heavy internet users who prefer on-demand streaming.

b The sample is biased and does not reflect the entire population. Broadcasters might put more resources into on-demand streaming and not meet the needs of free-to-air viewers.

5 **a** The use of the word 'alarming' in the headline suggests a major problem with loneliness.

b Just because people say they have no close relationships does not mean they are lonely. The survey asked if they had close relationships, not if they were lonely.

Chapter review

1 **a** The sample (i.e. work colleagues) is not representative of the target population (i.e. younger people).

b Survey his son's friends and/or friend's parents to find out what platforms they use.

2 **a** questioning error

b Relies on the respondent remembering how many times they have visited that store over a long period of time.

c Reduce the time frame. Ask if this is the main hardware store they visit.

3 **a** No; this is a biased question that leads to a particular response.

b No; this is a biased question that leads to a particular response.

c This is a better question but using 'assistance' implies the unemployed are disadvantaged and require sympathy, so is somewhat leading.

d This is a good question having no bias and is not a leading question.

4 Mrs Tall will not be as accurate as she would have been had she measured in centimetres. Students' shoes will have varying sole thickness and this will affect the measurements taken.

5 The Mathematics teachers are not representative of the target population. Staff members from all areas should have been included in the survey.

6 Where do you think we should hold the staff Christmas party this year?

7 **a** 57 mm **b** 6 cm
c 3 mm **d** 5.3%

8 **a** 11.2 kg **b** 11 200 g
c 100 g **d** 11 150 g
e 11 249 g **f** ± 50 g
g 0.29%

9 The timing of the poll would influence the way people vote, so there is procedural error where there is influence. Respondents are self-selecting and limited to those people who have the app on their phone, so the sample is biased

10 **a** Only parents from the one volleyball team were sampled. The survey should have included parents from other sports and teams to be more representative of the target population; that is, parents of children at the school playing sport.

b Questions should ask what you want to know. The parents were not asked if they felt the teams needed more training.

c The interpretation had nothing to do with the question asked.

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11 A; possible cause and effect relationship. Students could be able to work more productively with laptops.
B; unlikely to have an impact on academic performance. There is no obvious relationship between the two observations.
C; possible cause and effect relationship. Students could be able to understand more with extra help.
D; possible cause and effect relationship. Students could be able concentrate more without the distraction.
E and B; unlikely to have an impact on academic performance. There is no obvious relationship between the two observations.

12 As men's participation has declined, women's has increased. This could be because more women are accessing higher education, better access to child care and improved flexibility in work arrangements.

13 a 2014 12.5 years, 2016 13.1. This is an increase of 0.6 years. This is not a large change. The average can be influenced by a few pieces of data that are very high. If one or two cars were aged over 20 years, this could increase the average age of the cars involved in fatal accidents.

b Older cars are usually driven by younger drivers, who are inexperienced, or older drivers. Both groups are more likely to be involved in accidents regardless of the age of their vehicle.

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Glossary

A

Accuracy How close to the real value a measurement is

Ambiguity A phrase, word or question that is unclear and open to more than one interpretation

Annual Occurring once every year

Area The measurement of the surface

Arrival time Time when a bus or train reaches the stop

Association A relationship where one variable can be used to predict the other

Australian Taxation Office (ATO) The government department responsible for collecting tax

Average A single number that best represents a set of values

Average rate The total change in one quantity divided by the total change in the second quantity

Average speed The average rate at which distance changes with time

Axes The vertical and horizontal lines that define the number plane quadrants

Axes scale A system of ordered marks at fixed intervals referred to as a standard in measurement

Axes/sector labels Words or numbers used to name the axes of a graph and/or sectors of a pie graph

B

Bar graph A diagram in which horizontal rectangles or columns are used to represent data

Best buy A purchase where the largest amount of a particular item is obtained for each dollar spent

Bias The external influence of responses, which could potentially cause the results to be different from the true results

Break-even point The point where revenue and expenses are equal

Broken scale An axis with a break or gap in its values

C

Calories Unit of energy that is used for food

Categorical data Data that can be put into separate and distinct categories, like red or blue.

Census A survey of an entire population

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Colon The symbol:, which is used in ratios and operates similarly to the horizontal line of a fraction

Column graph A graphical representation of a single set of categorical or discrete data, where columns are used to show the frequency of scores

Commission Earnings of a salesperson based on a percentage of the value of goods or services sold

Compass A device used to find direction; a diagram used to show direction

Continuous data Data that can take any numerical value. This is data that is measured.

Conversion Changing (converting) a value to the equivalent value expressed in a different form

Cost price The cost to the owner when goods are purchased by a store

D

Data Information gathered by observation, survey or measurement; e.g. in a probability experiment. Singular of data is 'datum'.

Data series A list of data on one row or column that is in the same category of data

Dataset Information from different trials or sources

Denominator The number in a fraction below the horizontal line. It is the number of equal parts into which the whole is divided.

Departure time Time when a bus or train leaves the stop

Digital format A method of displaying time, where the time of day is displayed as digits

Direct proportion The relationship between two quantities that increase or decrease at the same rate (also called direct variation)

Discount An amount subtracted from a price, usually to sell goods faster

Discounted price The final price you pay once the discount has been subtracted

Discrete data Data that can take only particular numerical values. This is data that is counted.

Distance The measure of how far apart two objects are. See length.

Distance–time graph A line graph showing the distance travelled on the vertical axis and the time on the horizontal axis

Dot plot A graph in which each dot represents one data value

Double time Rate of earning money that is twice the normal hourly rate

Double time and a half Rate of earning money that is 2.5 times the normal hourly rate

Due In the exact direction

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E

Employee A person who earns income working for someone else

Employer A person who hires people to work for them

Equivalent fraction/ratio Fractions and ratios that represent the same amount. They can be reduced to the same basic fraction or ratio.

Ethics The moral principles governing how people act and how things should be done

Excluded value A value not part of a line segment in a step graph. Represented by an open (hollow) circle.

F

Factor A whole number that will divide into another number without a remainder

Financial year The period of time from 1 July to 30 June of the next year. At the end of the financial year, the taxable income of a person will be calculated.

Fixed expenses Expenses for living that usually stays the same over the period of a year

Fortnight A 2 week period; 14 days in a row

Frequency The number of times a data value occurs

Frequency (distribution) table A table summarising data by showing all possible scores, from lowest to highest, in one column, and the frequency of each score in another column

Fully simplified fraction/ratio A fraction or ratio in which both of their numbers are divided by their highest common factor (HCF)

G

Goods and Services Tax (GST) A government levy or tax included in the purchase price of merchandise. In Australia, this rate is 10%.

Graph The representation of data in a diagram

Gross pay Total income before any deductions (e.g. income tax) are made

H

Hectare (ha) A unit of measurement for area equal to 10 000 m^2.

Highest common factor (HCF) The largest number that is a factor of all the given factors

Histogram A special type of column graph with no gaps between the columns; it can represent class intervals

Horizontal axis Horizontal axis on the number plane

Horizontal axis intercept The value where the line of a graph crosses the horizontal axis

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I

Included value A value part of a line segment in a step graph. Represented by a closed circle

Income Money that 'comes in' (i.e. money you earn rather than money you spend). In most cases this will be the same as gross income.

Income tax payable The amount of tax an individual must pay

Interviewer bias The influence of a response caused by the interviewer

J

Jargon Special technical words used by a particular profession or group and are not well-known to the general population

K

Kilocalorie (kcal) Unit of energy that is used for food, where 1 kcal = 1 calorie

Kilojoules (kJ) Unit of energy that is used in food, where 1 kcal = 4.2 kJ

Kilowatt hours (kWh) Unit of energy used to measure electricity usage

L

Length The measurement of the distance from end to end along a line; the longest dimension of a 2D shape or 3D object

Length units Units of measurement for length. Examples include millimetre, centimetre, metre and kilometre.

Line graph A graph that shows the data as points joined with line segments.

Line segment scale A way of displaying the map's scale, by displaying a length of line to show the relationship between the scale distance of the map and the actual distance

Linear graph A line on the graph showing the relationship between two variables

Logbook method A system of calculating deductions for car expenses

Lowest common denominator (LCD) The smallest number that two or more denominators divide into without any remainder

Lowest common multiple (LCM) The smallest number that two or more numbers divide into without any remainder

M

Marked price The selling price, equal to the sum of the cost price and mark-up

Mark-up The amount added to the cost price to find the selling price (usually expressed as a percentage of the cost price)

Mass The amount of matter (material) in a body. Metric units for measuring mass are the gram (g) and kilogram (kg).

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Measurement error An error made during the process of collecting or recording of data

Medicare levy A percentage of taxable income paid by Australians (at end of financial year or via PAYG tax instalments) to fund Medicare, a scheme that gives Australian residents access to health careMedicare levy for the financial year 2013–14 = 1.5%
Medicare levy for the financial year 2014–15 = 2% (to fund the National Disability Insurance Scheme)

Misleading Giving the wrong idea or impression. Can be used to describe graphs if they make the data look better or worse than it actually is

Moon phases The shape of the visible (sunlit) Moon.

N

Net pay Income remaining after any deductions (e.g. income tax) have been made

Non-response bias The effect on a survey's results caused by the difference between people who do and do not respond

Numerator The number in a fraction above the horizontal line

Numerical (data) Data that is measured using numbers

O

Off-peak rates Usage price charged during periods when there is less demand for a service, such as electricity

Outlier A value that is much larger or much smaller than the rest of the data

Overtime Hours worked extra to normal working hours

P

Parallax error An error caused by a person reading measurements from tools, such as rulers, at an angle. This causes results to be consistently too high or low.

Pay as you go (PAYG) Pay as you go income tax instalment that is deducted from your wage or salary by your employer each time you are paid, and sent to the Australian Tax Office (ATO). The tax instalment is based on your expected end of financial year income tax liability and is calculated using tables and online calculators provided by the ATO. You can also opt to have Medicare levy instalments included in your PAYG tax.

PAYG payment summary A summary showing an employee's income, and the amount of tax withheld

Payslip A document listing the hours worked, gross and net income, superannuation contributions and tax withheld

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Peak rates Usage price charged during periods when there is a high demand for a service, such as electricity

Penalty rate An amount of pay per hour that is more than the regular amount, and applies during weekends or public holidays

Per Per means 'for each'. It is used when the number of units of one quantity is given for each unit of another quantity. This is a rate. Per may be abbreviated to 'p' but, in units, it is usually shown as a forward slash '/' (also known as a solidus). This is also a symbol for division because to calculate a rate you have to divide one quantity by another.

Per annum (p.a.) Each year

Per cent (%) A fraction with one hundred equal parts where only the numerator is shown followed by the percentage sign %. The sign indicates that the denominator of the fraction is 100.

Picture graph A graph where pictures are used to represent data. Also called a pictogram.

Pie graph A graph where the size of each sector of the circle represents a particular amount (also called a pie chart)

Piecework Employment where payment is made for each piece of work completed

Point of intersection The point at which two lines cross each other and therefore have the same coordinates

Precision How close the measurements are to each other

Principal An amount of money invested in a financial institution or loaned to a person or business

Privacy The ability for someone to hide information about themselves and choose what they want to reveal

Processing error Mistakes occurring when collecting data

Profit The amount of money made by selling something for more than its cost

Q

Questionnaire bias When a response is influenced by the wording of the question itself

R

Random Done without conscious decision; all events have a chance of happening but there is no way to know which event will definitely happen.

Range The difference between the highest and lowest numbers in a set

Rate The number of units of one quantity for each single unit of another quantity

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Ratio A method used to compare two or more quantities measured in the same units

Representative The sample reflects the entire population

Respectively In the same order as that listed

Retainer A set amount a company pays to 'retain' (i.e. keep) the services of an employee who is paid on commission even if they make no sales or do no work during that time period

S

Salary An employee's fixed agreed yearly pay (usually paid weekly, fortnightly or monthly)

Sample A small group randomly selected from the population

Sample population The group of individuals asked to participate in a survey

Sampling error Influence or error in results caused by a mistake or because the sample size was too small

Sampling technique Method of gathering a sample for a survey

Scale A ratio that compares a drawing or a model to the real object

Scale factor The number by which you multiply each side length to enlarge or reduce the size of a shape

Scale model A replica of an object that has a different size to the actual object

Self-selected sample A sample where members of the population volunteer themselves to complete the survey

Self-selection bias Influence from voluntary survey respondents interested in a particular viewpoint

Simple interest Percentage rate per year paid on a loan or investment amount. Simple interest is generally charged on money borrowed or invested for a short period of time.
Formula: simple interest = principal × rate × time
Where principal is the amount borrowed or invested, rate is the percentage charged per time period (e.g. daily, monthly or yearly) for interest, and time is the total number of time periods of the loan or investment. Note that when using the formula, the units of time for the interest rate and total number of time periods must match. If the time is stated in years and the interest rate is given in a percentage per month, first convert the time in years to months.

Simple random sample A sample where everyone is randomly selected

Speed A measure of how fast an object is moving

Spreadsheet A table comprised of rows and columns for entering data and headings. Computer spreadsheet programs allow you to enter formulas

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that will manipulate data electronically and update results immediately when data is changed.

Stem-and-leaf plot A graph that lists numbers in order, grouped in rows

Step graph A special type of line graph that jumps in steps

Strata A group within a population that reflects the characteristics of the entire population

Stratified sample A sample using categories or strata of a population. Members from each category are randomly selected. For example, one student is selected from each Year 7, 8, 9, 10, 11 and 12.

Study population Group of individuals who agree to participate in a survey

Sunrise/sunset charts A table showing sunrise and sunset times

Superannuation An investment to which your employer must contribute by law and to which you may contribute part of your salary. It is compulsory in the hope that retirees will have enough funds for a comfortable retirement and will not have to rely on the age pension, which is funded by tax payers.

Survey A set of questions, which participants answer, designed to find out about something

Systematic (route calculation) Selection method where the shortest distance is selected from each next location

Systematic error An error that repeatedly occurs, either from human error or a faulty measuring device

Systematic sample A sample that divides the population into a structured sample size; for example, sorting the names of people in alphabetical order and selecting every fifth person.

T

Table An arrangement of data using rows and columns of boxes

Tally marks Line strokes used to record data, usually in groups of 5

Target population The entire group of individuals the survey is interested in

Tax Money taken out of a person's income and given to the government for funding of services

Taxable income Gross income less certain deductions allowed by the tax office. These include donations to charity and expenses related to earning income, such as uniforms or equipment required for a job.

Tax bracket The upper and lower limits of income for which a particular level of tax is paid

Tax deductions An amount that you can subtract from your gross income under tax office rules, to calculate your taxable income

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Tax file number (TFN) A unique number to identify a taxpayer's (e.g. individuals and companies) Australian tax payments

Tax-free threshold The maximum amount of annual income that does not need to be taxed

Taxable income The gross income less certain items allowed by the tax office. These include donations to charity and expenses related to earning income such as uniforms or equipment required for a job.

Tax payable The amount of tax an employee must pay according to the tax bracket in which their income falls

Tax refund/debt The amount given back to the taxpayer if they have paid more tax over the year (e.g. PAYG) than they were supposed to

Tax returns A document declaring all income, tax paid, deductions and calculations for taxable income and amount of tax payable

Tide tables A table used to show a specific location's high and low tide heights and times.

Time Period of existence that is measured in seconds, minutes, hours, days, weeks, months, years and so on; this process considered as a whole

Time and a Half Rate of earnings that is one and a half times an employee's normal hourly rate

Time difference The length of a period of time between two times

Timesheet A list of the number of hours worked by the employee over the pay period

Timetable A list of times at which possible events or actions are intended to take place

Travel time Period of time needed to reach the destination from the starting point

Trends A general shape or direction created by data

Trial and error A method of solving problems where multiple varied attempts are done until the problem is solved

Two-way table A table with columns and rows recording the numbers of items belonging to different categories

U

Uniform Having all the parts or elements the same; sharing the same characteristics

Unit of measure Standard quantity used for measurement

V

Variable expenses Expenses for living that can change frequently, depending on circumstances

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Vertical axis Vertical axis on the number plane

Vertical axis intercept The value where the line of a graph crosses the vertical axis

W

Wage Earnings paid to an employee based on an hourly rate for an agreed number of hours each week

X

***x*-axis** See horizontal axis

Y

***y*-axis** See vertical axis

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Glossary of cognitive verbs

A

analyse dissect to ascertain and examine constituent parts and/or their relationships; break down or examine in order to identify the essential elements, features, components or structure; determine the logic and reasonableness of information; examine or consider something in order to explain and interpret it, for the purpose of finding meaning or relationships and identifying patterns, similarities and differences

apply use knowledge and understanding in response to a given situation or circumstance; carry out or use a procedure in a given or particular situation

appraise evaluate the worth, significance or status of something; judge or consider a text or piece of work

appreciate recognise or make a judgement about the value or worth of something; understand fully; grasp the full implications of

argue give reasons for or against something; challenge or debate an issue or idea; persuade, prove or try to prove by giving reasons

assess measure, determine, evaluate, estimate or make a judgment about the value, quality, outcomes, results, size, significance, nature or extent of something

C

calculate determine or find (e.g. a number, answer) by using mathematical processes; obtain a numerical answer showing the relevant stages in the working; ascertain/determine from given facts, figures or information

categorise place in or assign to a particular class or group; arrange or order by classes or categories; classify, sort out, sort, separate

clarify make clear or intelligible; explain; make a statement or situation less confusing and more comprehensible

classify arrange, distribute or order in classes or categories according to shared qualities or characteristics

comment express an opinion, observation or reaction in speech or writing; give a judgement based on a given statement or result of a calculation

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communicate convey knowledge and/or understandings to others; make known; transmit

compare display recognition of similarities and differences and recognise the significance of these similarities and differences

comprehend understand the meaning or nature of; grasp mentally

conduct direct in action or course; manage; organise; carry out

consider think deliberately or carefully about something, typically before making a decision; take something into account when making a judgement; view attentively or scrutinise; reflect on

construct create or put together (e.g. an argument) by arranging ideas or items; display information in a diagrammatic or logical form; make; build

contrast display recognition of differences by deliberate juxtaposition of contrary elements; show how things are different or opposite; give an account of the differences between two or more items or situations, referring to both or all of them throughout

create bring something into being or existence; produce or evolve from one's own thought or imagination; reorganise or put elements together into a new pattern or structure or to form a coherent or functional whole

critique review (e.g. a theory, practice, performance) in a detailed, analytical and critical way

D

decide reach a resolution as a result of consideration; make a choice from a number of alternatives

deduce reach a conclusion that is necessarily true, provided a given set of assumptions is true; arrive at, reach or draw a logical conclusion from reasoning and the information given

define give the meaning of a word, phrase, concept or physical quantity; state meaning and identify or describe qualities

demonstrate prove or make clear by argument, reasoning or evidence, illustrating with practical example; show by example; give a practical exhibition

derive arrive at by reasoning; manipulate a mathematical relationship to give a new equation or relationship; in mathematics, obtain the derivative of a function

describe give an account (written or spoken) of a situation, event, pattern or process, or of the characteristics or features of something

design produce a plan, simulation, model or similar; plan, form or conceive in the mind; in English, select, organise and use particular elements

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in the process of text construction for particular purposes; these elements may be linguistic (words), visual (images), audio (sounds), gestural (body language), spatial (arrangement on the page or screen) and multimodal (a combination of more than one)

determine establish, conclude or ascertain after consideration, observation, investigation or calculation; decide or come to a resolution

develop elaborate, expand or enlarge in detail; add detail and fullness to; cause to become more complex or intricate

devise think out; plan; contrive; invent

differentiate identify the difference(s) in or between two or more things; distinguish, discriminate; recognise or ascertain what makes something distinct from similar things; in mathematics, obtain the derivative of a function

discriminate note, observe or recognise a difference; make or constitute a distinction in or between; differentiate; note or distinguish as different

discuss examine by argument; sift the considerations for and against; debate; talk or write about a topic, including a range of arguments, factors or hypotheses; consider, taking into account different issues and ideas, points for and/or against, and supporting opinions or conclusions with evidence

distinguish recognise as distinct or different; note points of difference between; discriminate; discern; make clear a difference(s) between two or more concepts or items

document support (e.g. an assertion, claim, statement) with evidence (e.g. decisive information, written references, citations)

E

evaluate make an appraisal by weighing up or assessing strengths, implications and limitations; make judgements about ideas, works, solutions or methods in relation to selected criteria; examine and determine the merit, value or significance of something, based on criteria

examine investigate, inspect or scrutinise; inquire or search into; consider or discuss an argument or concept in a way that uncovers the assumptions and inter-relationships of the issue

execute apply a procedure to a familiar task; perform a procedure without significant error, but not necessarily understanding how and why the procedure works; produce in accordance with a plan or design; put into effect a plan, order or course of action

experiment try out or test new ideas or methods, especially in order to discover or prove something; undertake or perform a scientific procedure to test a hypothesis, make a discovery or demonstrate a known fact

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explain make an idea or situation plain or clear by describing it in more detail or revealing relevant facts; give an account; provide additional information

explore look into something both closely and broadly; scrutinise; inquire into or discuss something in detail

express convey, show or communicate (e.g. a thought, opinion, feeling, emotion, idea or viewpoint); (in words, art, music or movement) convey or suggest a representation of; depict

extrapolate infer or estimate by extending or projecting known information; conjecture; infer from what is known; extend the application of something (e.g. a method or conclusion) to an unknown situation by assuming that existing trends will continue or similar methods will be applicable

G

generate produce; create; bring into existence

H

hypothesise formulate a supposition to account for known facts or observed occurrences; conjecture, theorise, speculate; especially on uncertain or tentative grounds

I

identify distinguish; locate, recognise and name; establish or indicate who or what someone or something is; provide an answer from a number of possibilities; recognise and state a distinguishing factor or feature

implement put something into effect such as a plan or proposal

infer derive or conclude something from evidence and reasoning, rather than from explicit statements; listen or read beyond what has been literally expressed; imply or hint at

interpret use knowledge and understanding to recognise trends and draw conclusions from given information; make clear or explicit; elucidate or understand in a particular way; bring out the meaning of a dramatic or musical work by performance or execution; bring out the meaning of an artwork by artistic representation or performance; give one's own interpretation of; identify or draw meaning from, or give meaning to, information presented in various forms, such as words, symbols, pictures or graphs

investigate carry out an examination or formal inquiry in order to establish or obtain facts and reach new conclusions; search, inquire into, interpret and draw conclusions about data and information

J

judge form an opinion or conclusion about; apply both procedural and deliberative operations to make a determination

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justify give reasons or evidence to support an answer, response or conclusion; show or prove how an argument, statement or conclusion is right or reasonable

M

make decisions select from available options; weigh up positives and negatives of each option and consider all the alternatives to arrive at a position

manipulate adapt or change to suit one's purpose

modify change the form or qualities of; make partial or minor changes to something

O

organise arrange, order; form as or into a whole consisting of interdependent or coordinated parts, especially for harmonious or united action

P

predict give an expected result of an upcoming action or event; suggest what might happen based on available information

propose put forward (e.g. a point of view, idea, argument, suggestion) for consideration or action

prove use a sequence of steps to obtain the required result in a formal way

R

realise create or make (e.g. a musical, artistic or dramatic work); actualise; make real or concrete; give reality or substance to

recall remember; present remembered ideas, facts or experiences; bring something back into thought, attention or into one's mind

recognise identify or recall particular features of information from knowledge; identify that an item, characteristic or quality exists; perceive as existing or true; be aware of or acknowledge

reflect on think about deeply and carefully

resolve (in the Arts) consolidate and communicate intent through a synthesis of ideas and application of media to express meaning

S

select choose in preference to another or others; pick out

sequence place in a continuous or connected series; arrange in a particular order

sketch execute a drawing or painting in simple form, giving essential features but not necessarily with detail or accuracy; in mathematics, represent by means of a diagram or graph; the sketch should give a general idea of

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the required shape or relationship and should include features

solve find an answer to, explanation for, or means of dealing with (e.g. a problem); work out the answer or solution to (e.g. a mathematical problem); obtain the answer(s) using algebraic, numerical and/or graphical methods

structure give a pattern, organisation or arrangement to; construct or arrange according to a plan

summarise give a brief statement of a general theme or major point(s); present ideas and information in fewer words and in sequence

symbolise represent or identify by a symbol or symbols

synthesise combine different parts or elements (e.g. information, ideas, components) into a whole, in order to create new understanding

T

test take measures to check the quality, performance or reliability of something

U

understand perceive what is meant by something; grasp; be familiar with (e.g. an idea); construct meaning from messages, including oral, written and graphic communication

use operate or put into effect; apply knowledge or rules to put theory into practice

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